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A NEW GERRID FROM CHINA (Gerridae, Hemiptera)[1]

H. B. Hungerford

In 1934 Dr. O. Lundblad described *Esakobates svenhedini* new genus and species from Szechuan, China.[2] His specimens were all apterous forms and he published a splendid drawing of an adult female and ten drawings of structural parts. In 1937 I received seven specimens of a winged form, all of which have their wings broken off before the tip of the pronotal lobe. They came from Tien um Shan, China. I assumed that they represented the winged form of Dr. Lundblad's species and was delighted to have them. Recently, however, I sent a pair to Dr. Lundblad and he writes that they are not his species. Therefore I must describe the species as new.

Esakobates lundbladi sp. n.

Size. Deälated winged forms, male 8.4 mm. long; 2.6 mm. across humeri; female 12.2 mm. long; 2.64 mm. across humeri.

Color. Black trimmed with yellowish brown above, mostly yellowish brown on the venter, all beneath a silvery pile. Antennae nearly black, tibiae and tarsi dark. Head yellowish brown, clypeus dark, an elongate median black band on vertex, bifurcate behind; pronotum black, margined on the sides and rear with yellowish brown, a large triangular or nearly round yellowish brown spot on anterior lobe of pronotum and anteriorly a median line of same color reaches margin and posteriorly may surpass humeri. Connexiva of females, acetabula, coxae, and trochanters yellowish brown. Mesonotum, metanotum, abdominal tergites, most of mesopleura and all but median line of anterior half of mesosternum black. Sides of abdomen with black band. There may be yellowish brown spots on median line of mesonotum, metanotum, and some abdominal tergites.

Structural characteristics. Male—Relative lengths of antennal segments are 1st: 2nd: 3rd: 4th:: 195: 50: 60[3]: 45[3]. Beak short, stout, not reaching mesosternum.

Relative lengths of leg segments:

	Femur	Tibia	Tarsal seg. 1	Tarsal seg. 2
Front leg	200	160	60	38
Middle leg	555	285	110	21
Hind leg	560	220(?)[4]	6	10

Antennae stout, first segment longer than other three. Front legs also stout, front femur straight and much thicker than tibia which has a lateral

[1] Contribution No. 923 from the Department of Entomology, University of Kansas. This paper is a by-product of a project aided by a grant from the National Science Foundation.

[2] Arkiv för Zoologi. K. Svenska Vetenskapsakademien. Band 27 A, No. 14, pp. 22-26. Fig. 10 and Taf. II, Figs. 4 and 5. 1934.

[3] Including accessory segment.

[4] Curvature makes accuracy difficult.

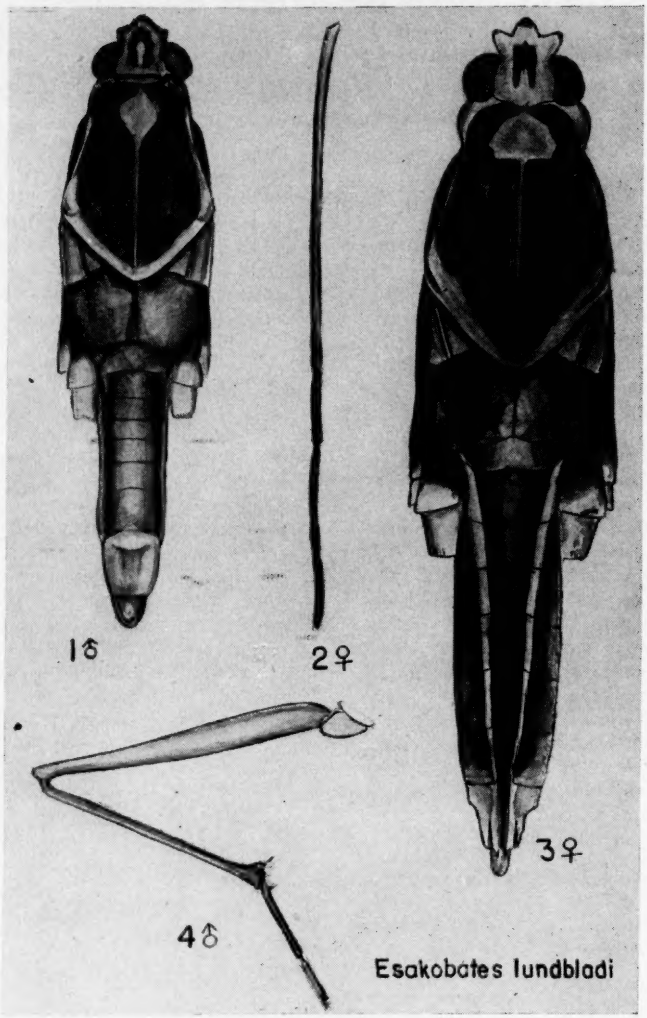


PLATE I

Esakobates lundbladi Hungerford. 1. Deälated winged male. 2. Left antenna of female. 3. Deälated winged female. 4. Left front leg of male.

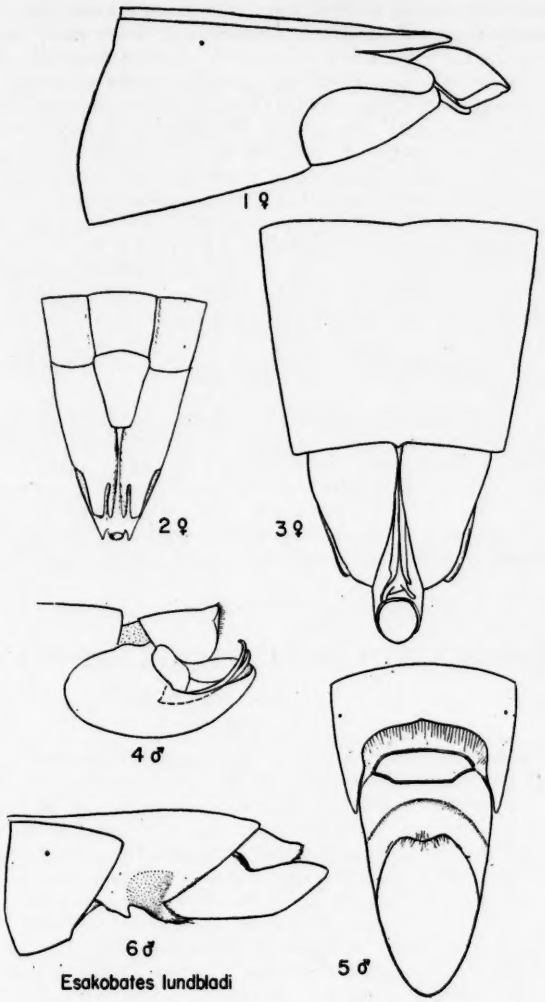


PLATE II

Esakobates lundbladi Hungerford. 1. Left side of female abdominal tip. 2. Dorsal view of female abdominal tip. 3. Ventral view of female abdominal tip. 4. Male genital capsule (side view). 5. Male genital segments (ventral view). 6. Male genital segments (side view).

projection before tip; first tarsal segment strikingly longer than second; claws anteapical, curved. Middle femur somewhat stouter than hind femur, its tibia with what appears to be band of procumbent dark hairs its entire length. Tibia of hind leg, under high power binocular microscope, shows close set row of short hairs, curved at their tips. Surface of femur and tibia covered with short, sharp spinose hairs. Metaacetabulum above mesoacetabulum and mesocoxa so that hind leg arises above middle leg. Connexivum of male nearly vertical and ending in short projection. Connexivum of female more or less vertical but on last segment reflexed and meeting that of the other side on distal half; its curious bilobed tip having inner lobe narrow and pointed and outer lobe broad and rounded at tip, these two lobes extending well beyond ventral line of segment. First genital segment of male connected ventrally with last abdominal segment by transverse sclerotized plate that is attached within and before margin of abdominal segment and bears transverse ridge across middle. Front edge of first genital segment is transversely ridged, behind which it is depressed, then enlarged as shown in drawings.

COMPARATIVE NOTES. This species may be distinguished from *Esakobates svenhedini* Lundblad by the much longer inner lobe of the last connexival segment in the female and by the genital segments in the male.

Location of types: Described from four males and three females labeled "Tien um Shan, China, September 21, 1937. E. Suenson." The holotype male, allotype female and five paratypes are in the Snow Entomological Museum, University of Kansas. Two of the above are badly damaged.

A NEW SPECIES OF MALLOPHAGA FROM A DOVE

K. C. EMERSON
Stillwater, Oklahoma

The Ischnoceran genus *Physconelloides* Ewing, 1927, contains six species found on the avian order Columbiformes. The known species and type hosts are: *P. ceratoceps* Ewing, 1927, found on *Leptoptila verreauxi chalcauchenia* (Sclater and Salvin); *P. eurysema* (Carriker), 1903, found on *Claravis mondetoura umbrina* Griscom; *P. galapagensis* (Kellogg and Kuwana), 1902, found on *Nesopelia galapagoensis galapagoensis* (Gould); *P. mattogrossensis* (Guimaraes), 1936, found on *Columbigallina minuta minuta* (Linnaeus); *P. recurvatus* Eichler, 1949, found on *Columbina picni picni* (Temminck); and *P. zenaidurae* (McGregor), 1917, found on *Zenaidura macroura marginella* (Woodhouse). A new species is herewith described from material in the U.S. National Museum and the British Museum (Natural History).

Physconelloides zenaidurae (McGregor), 1917

This species, found on the Mourning Dove, has been the only member of the genus recorded from the United States. It is seldom found in abundance on an individual host, but has been collected throughout the range of the Mourning Dove. Recently, twenty-six domestic pigeons, collected in the vicinity of Leavenworth, Kansas, were examined for Mallophaga. Six adults of this form were collected off three of the pigeons examined.

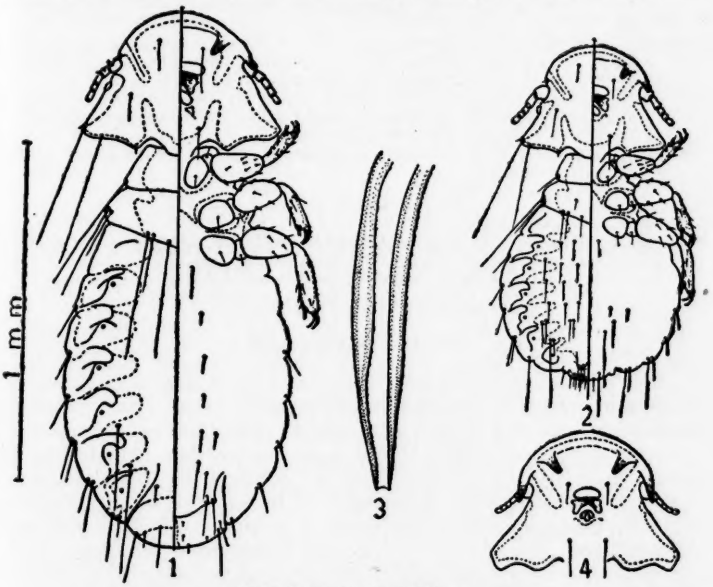
Whether it is established on the domestic pigeon elsewhere in the United States has not been determined at this time. Illustrations of the species are shown in figures 1-3.

Physconelloides passerinae n. sp.

This species is closest to *P. zenaidurae* (McGregor), 1917. The major differences between the two are that in both sexes, the ventral, anterior, spine-like processes of the forehead; and the lateral, preantennal, spine-like processes are considerably longer in the new form. These differences are evident from a comparison of figures 2 and 4. In the male, there are two rather than three setae in the posterior lateral angles of the genital opening. There appears to be no significant difference in the male genitalia. In *P. zenaidurae,* the vulva of the female possesses two long setae in the posterior lateral angles, the remainder of the posterior margin being bare. In the new form, the vulva of the female possesses a row of setae on the posterior margin and is without setae in the posterior lateral angles.

Type host: *Columbigallina passerina passerina* (Linnaeus), Eastern Ground Dove.

Type material: Holotype male and allotype female (USNM #63408) collected on March 3, 1956, at Bainbridge, Georgia, by Dr. Sturgis Mc-



EXPLANATION OF FIGURES

Figures 1, 2 and 4 drawn to same scale. Figures 1-3. *Physconelloides zenaidurae* (McGregor); fig. 1, dorsal-ventral view of female; fig. 2, dorsal-ventral view of male; fig. 3, male genitalia. Figure 4. *Physconelloides passerinae* n. sp., male; ventral view of head.

Keever, Newton Field Station, U.S. Public Health Service. Paratypes from *Columbigallina passerina insularis* Ridgway, in the U.S. National Museum, collected by H. S. Peters are: 4 males, 8 females on Cayman Brac, B. W. I.; 4 males, 2 females on Grand Cayman, B. W. I.; 9 males, 7 females at Guantanamo, Cuba; 1 female at Puerto Portillo, Cuba; 1 male at Pilon, Cuba; and 2 females on Isle of Pines, Cuba. Paratypes, in the U.S. National Museum, from *Columbigallina passerina bahamensis* (Maynard), collected by H. S. Peters in the Bahama Islands, B. W. I., as follows: 1 male on Grand Caicos; 6 males, 4 females at Pine Cay, Caicos Island; 8 males, 12 females on Ragged Island; 1 male, 2 females on Mariguana Island; 1 male, 8 females on Crooked Island; 5 males, 3 females on Acklin Island; 1 male at Salt Cay, Turks Island; and 1 female on Anguila Island. In the British Museum (Natural History) is 1 male paratype collected in Salvador from *Columbigallina passerina pallescens* (Baird).

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THE IDENTITY OF *OSMIA INTEGRELLA* COCKERELL AND ITS RELATIVES (Hymenoptera, Megachilidae)

CHARLES D. MICHENER[1]

This paper is written to provide names for two species of *Osmia* for a forthcoming review of species of the *universitatis* group. That a problem in the identification of *O. integrella* Cockerell existed first became apparent to me on a recent visit to the United States National Museum when I noticed a series labeled by the late Grace A. Sandhouse as "*Osmia integrella* Sandhouse, not Cockerell." Examination of the original description of *O. integrella* Cockerell, 1907, shows that it is a synonym of *O. universitatis* Cockerell (new synonymy), and the name was probably consistently used for variants of *universitatis* by Cockerell, to judge by specimens before me which he identified. The type of *integrella* has not been located (it is not in the American Museum of Natural History, the U.S. National Museum, nor

[1] Contribution number 962 of the Department of Entomology, University of Kansas.

the Museum of the University of Colorado) but an essentially topotypical specimen identified by Cockerell in the last mentioned museum has been examined. Cockerell's statements that the third metasomal sternum is deeply emarginate, the third antennal segment shorter than the fourth, and the seventh tergum with a pair of short, widely separated teeth all show that *integrella* Cockerell is among the forms now considered as color variants of *universitatis*.

The *integrella* of Sandhouse (1939) is therefore in need of a new name, as seems to have been discovered by Sandhouse before her death. The differentiating characters of this and an additional closely related new species are listed in Table I.

TABLE I. Characters of *Osmia universitatis* and its relatives (males)

O. universitatis Ckll.	*O. thysanisca* n. sp.	*O. raritatis* n. sp.
First flagellar segment on short side about three-fourths as long as second; middle flagellar segments twice as long as broad.	First flagellar segment on short side about as long as second; middle flagellar segments less than twice as long as broad.	First flagellar segment on short side about as long as second; middle flagellar segments less than twice as long as broad.
Hind basitarsus nearly parallel-sided.	Hind basitarsus broadest near middle, tapering toward both ends.	Hind basitarsus broadest basad of middle, sometimes almost parallel-sided.
Emargination of third sternum deep, less than one-third as wide as sternum, fringe golden.	Emargination of third sternum very shallow, less than one-sixth as wide as sternum, fringe whitish.	Emargination of third sternum shallow, less than one-fourth as wide as sternum, fringe golden.
Fourth sternum broadly truncate.	Fourth sternum broadly rounded.	Fourth sternum broadly subtruncate (i.e., truncation slightly rounded).
Sixth sternum with apex of process convex, lateral margins diverging apically (Sandhouse, 1939, fig. 121).	Sixth sternum with median process emarginate, its lateral margins converging posteriorly (Sandhouse, 1939, fig. 124).	Sixth sternum with median process truncate, its lateral margins parallel (fig. 1).
Seventh tergum with lateral apical margins straight, emargination broad and shallow (fig. 4).	Seventh tergum with lateral apical margins convex, emargination deep (fig. 3).	Seventh tergum with lateral apical margins convex, emargination deep (fig. 2).

Osmia thysanisca new species

Osmia (Nothosmia) integrella, Sandhouse, 1939, Mem. Ent. Soc. Washington 1:84.

Length 7.5 mm. (varying among paratypes to 10 mm.).

This species was described and certain structures were figured by Sandhouse (1939). Its distinctive features are indicated in Table I. Of these, the small emargination of the third metasomal sternum is the most striking.

Holotype male: Wildhorse Canyon, Steens Mountains, Oregon, 4270-6000 feet altitude, July 5, 1927 (H. A. Scullen). Three male paratypes, one from each of the following localities: Fish Lake, Steens Mountains, Oregon, 7000 feet altitude, July 11, 1927 (H. A. Scullen); White Branch Meadow,

Three Sisters, Frog Camp, Oregon, 5500 feet altitude, July 19, 1927 (H. A. Scullen); Jackson Hole, Wyoming, June 20, 1936, on flowers of clover.

The holotype and the paratypes from Oregon are the property of the U.S. National Museum; the remaining paratype is the property of the Snow Entomological Museum.

Osmia raritatis new species

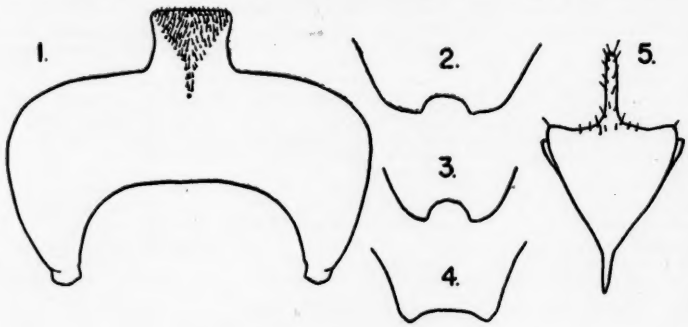
Osmia (Nothosmia) universitatis, Sandhouse, 1939, Mem. Ent. Soc. Washington 1:84 (part).

Length 8 mm.

At least one specimen of this species was confused with *O. universitatis* Cockerell by Sandhouse (1939). The distinguishing features are shown in Table I, from which it can be seen that *raritatis* is intermediate in various respects between *universitatis* and *thysanisca.* As the three forms are probably sympatric, there seems to be little danger that the characters listed in the table do not distinguish valid species. The most striking of the characters that distinguish *raritatis* from *universitatis* is the shape of the seventh tergum. The sixth abdominal sternum is more similar to that of *O. tanneri* than to other species but the hind basitarsus is not broad as in *tanneri.*

Holotype male: Camp Creek Ranger Station, Colorado, 8700 feet altitude, 41° 0′ N, 106° 12′ W, June 19, 1920. Two male paratypes are from Selah, Washington, May 4, 1919 (H. A. Scullen) and Myers, California, 6300 feet altitude, June 9, 1930.

The holotype and first paratype are the property of the U.S. National Museum. The second paratype is in the Snow Entomological Museum.



EXPLANATION OF FIGURES

1. Sixth metasomal sternum, *Osmia raritatis,* male.
2-4. Apex of seventh sternum of male, *O. thysanisca, O. raritatis,* and *O. universitatis.*
5. Eighth metasomal sternum, *Osmai raritatis,* male.

PRELIMINARY STUDIES OF GRANULAR INSECTICIDES AGAINST THE LONE STAR TICK

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University of Arkansas

Application of insecticides to the ground cover has long been known to be effective (3,4) against ticks. However, the use of ground machinery in roadless, brushy and wooded areas is out of the question. Application of spray or dust by airplane offers only limited possibilities because these insecticidal formulations will be deposited on the upper foliage and not get down to where it is needed (1). Granular formulations offer the means of depositing the insecticide at the site needed.

Initial curiousity as to the effectiveness of a granular formulation led to the application of some granular heptachlor to a lawn heavily infested with ticks. This material was of unknown concentration and the rate of application was not carefully measured. Where it was applied, good kill resulted.

METHODS

On the basis of rate of application of sprays and dusts (1,2,3), an experiment was designed to determine the effectiveness of granular dieldrin at one pound actual to the acre; heptachlor at one pound to the acre; and chlordane at two pounds to the acre. This experiment was set up in the greenhouse using flats, set in a sand table as individual plots. Fresh soil was brought in from the University Farm and oat plants grown to simulate cover. Sod was first tried but the ticks could not be readily located in the sod so that it was impossible to get counts on numbers dead and alive.

Each treatment except the check was replicated three times and two flats of each treatment were watered both from above and below. It was assumed that watering from above by sprinkling can would simulate the effects resulting from rainfall.

RESULTS

Treatment was first applied on October 18, 1955 and the ticks placed on the treated flats the following morning. All ticks were dead on all treatments except the check seven days later. No kill was observed in the check. Most of the ticks were dead by the third day and after that the results were checked only every other day.

These flats were left intact and watered regularly and ticks again placed on the treatments on February 11. After 7 days all were dead on the dieldrin treatments; none on all other treatments. Most were dead at 5 days.

This was repeated again March 12 on the dieldrin treatment and check only. Again all were killed by the dieldrin; no mortality resulted in the check. No kill was recorded until 5 days after exposure, and all were dead after 9 days.

Complete kill was also recorded on April 10 and May 4. Much of this kill came within 3 to 5 days after exposure. Whether higher temperature or the condition of the ticks caused quicker mortality was not determined.

The flats of soil were carried over in the greenhouse without watering but subject to summer greenhouse temperatures. Ticks were again placed on the soil, in which oat plants were growing, on October 6, 1956. By October 18, exactly one year from the initial soil treatment, all ticks were dead on the treated soil while 18 of 25 were still living on the check soil. Flies resting on the treated soil were also killed.

BIOASSAY OF SOIL

Soil samples from a strip about 8 inches long by one inch wide were taken from the dieldrin treated flats and the check flat. A top layer and bottom layer sample of about one inch depth was assayed with *Drosophila* and the results compared to a known standard. The results indicated that there were about 10 ppm in the top layer of one flat watered both from above and below. There was considerably less dieldrin in the bottom sample. On flats watered from the bottom only, there was little evidence of any movement downward in the soil.

SUMMARY

The use of granular dieldrin as a means of controlling ticks in wooded areas may be practical as shown by these preliminary investigations in the greenhouse.

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NEW *CROSSIDIUS* FROM CALIFORNIA (Coleoptera, Cerambycidae)

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The following new subspecies are described in order that the names may be available for use in a discussion of host plant relationships. The primary types are deposited in the California Academy of Sciences. Paratypes are in the collection of the California Insect Survey, University of California, Berkeley.

Crossidius rhodopus nubilus new subspecies

Form and size of *C. rhodopus rhodopus* but with the red or reddish-brown elytra extensively clouded with black. Length, 11-15 mm.

Holotype male, allotype female and forty-four paratypes (9 females, 35 males) from Westgard Pass, Inyo County, California, September 11, 1956, on *Chrysothamnus viscidiflorus typicus* (J. A. Chemsak, P. D. Hurd, and E. G. Linsley). Additional paratypes (7 females, 13 males) from the same locality were taken on *Chrysothamnus nauseosus gnaphalodes*.

Of the sixty-six examples available for study, one male has the elytra immaculate and six have the dark cloud reduced and covering less than half the surface of the elytra (thus intergrading with *rhodopus*). Fifty-five of sixty-two specimens of *C. rhodopus rhodopus* from Sherwin's Summit, Mono County, California, and northward have the elytra immaculate, seven have a small sutural cloud near apex. Thus, of the one hundred and twenty-eight examples of the two forms now at hand, fourteen (seven in each population sample) could not be properly assigned without reference to the locality label.

Crossidius ruficollis ascendens new subspecies[1]

Form and size of *C. ruficollis ruficollis* but bright red, with elytral markings bluish and, in the female, more extensive than in the typical subspecies. Length, 12-20 mm.

Holotype male, allotype female, and thirty paratypes (8 females, 22 males) two miles north of Lancaster, Los Angeles County, California, September 8, 1956, on *Chrysothamnus nauseosus mohavensis* (J. A. Chemsak, P. D. Hurd, E. G. Linsley). Additional paratypes are as follows: fourteen females, twelve males from four miles east of Monolith, Kern County, California, October 24, 1952, on *Chrysothamnus nauseosus mohavensis* (Ray F. Smith); three females, nine males from three miles east of Monolith, Kern County, California, September 8, 1956, on *Chrysothamnus nauseosus mohavensis* (J. A. Chemsak, P. D. Hurd); and one female, three males from two miles south of Rosamond, Kern County, California, October 24, 1952, on *Chrysothamnus nauseosus mohavensis* (Ray F. Smith).

This subspecies occurs in the western Mojave Desert.

Crossidius ruficollis caeruleipennis new subspecies

Form and size of *C. ruficollis ruficollis*. Color testaceous and black, pronotum somewhat rufo-testaceous; elytra of male immaculate or with a narrow posterior sutural stripe. In the female the dark areas are broad and similar in pattern to the typical subspecies but bluish as in *C. ruficollis ascendens*. Length, 12-21 mm.

Holotype male, allotype female, and twenty-four paratypes (6 females, 18 males) from one and one-half miles south of Lone Pine, Inyo County, September 9, 1956, on *Chrysothamnus nauseosus consimilis* (J. A. Chemsak, P. D. Hurd, E. G. Linsley). Additional paratypes, all from *Chrysothamnus nauseosus consimilis* are as follows: five females and thirty-six males from eight miles north of Lone Pine, Inyo County, September 9, 1956 (J. A. Chemsak, P. D. Hurd, E. G. Linsley); four females and

[1] *Crossidius coccineus*, Linsley (not Casey), 1955, Pan-Pacific Ent., 31:66 [misident.].

twenty-three males from eight miles south of Big Pine, Inyo County, September 9, 1956 (J. A. Chemsak, P. D. Hurd, E. G. Linsley); fourteen females and thirty-seven males from four miles south of Big Pine, Inyo County, September 9, 1956 (J. A. Chemsak); seven males from Round Valley, Inyo County, September 10, 1956 (J. A. Chemsak, E. G. Linsley); one male from two miles south of Keogh Hot Springs, Inyo County, September 10, 1956 (E. G. Linsley); six females and forty males from Rock Creek, Inyo County, September 11, 1956 (J. A. Chemsak, P. D. Hurd, E. G. Linsley), and three females and thirteen males from fifteen miles north of Bishop, Inyo County, August 8, 1948 (P. D. Hurd, J. W. MacSwain).

This subspecies occurs in the Owens Valley.

Crossidius intermedius pubescens new subspecies

Form and size of *C. intermedius intermedius* but generally paler, less heavily marked and more densely pubescent. Length, 11-17 mm.

Holotype male, allotype female, and forty-two paratypes from 2.8 miles east of Indio, Riverside County, California, October 23, 1951 (P. D. Hurd). Additional paratypes as follows: five miles northwest of Indio, October 26, 1952, two males (E. G. Linsley and R. F. Smith); two miles northwest of Indio, six males, one female (E. G. Linsley and R. F. Smith); five miles west of Westmoreland, October 26, 1952, twenty-one males, six females (E. G. Linsley and R. F. Smith); Kane Springs, Imperial County, October 14, 1948, one male, one female (L. D. Anderson and H. T. Reynolds); Niland, Imperial County, October 24, 1951, thirty-five males, one female (P. D. Hurd); and five miles southeast of Bohns Corner, Imperial County, October 27, 1952, six males (E. G. Linsley and R. F. Smith).

This subspecies occurs in southeastern California on *Haplopappus acradenius eremophilus*.

Crossidius intermedius minutivestis new subspecies

Form and size of *C. intermedius intermedius* but with the elytra much more shining and obscurely clothed with very short pubescence. Length, 11-15 mm.

Holotype male, allotype female, and ninety-four paratypes (10 females, 84 males) from two miles north of Lancaster, Los Angeles County, California, September 8, 1956, on *Haplopappus acradenius* (J. A. Chemsak, P. D. Hurd, E. G. Linsley).

This subspecies occurs on the western edge of the Mojave Desert.

FOUR NEW SPECIES OF THE GENUS *EURYTOMA* FROM GALLS ON HACKBERRY (Chalcidoidea, Hymenoptera)

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The following descriptions are based on specimens collected in Texas and reared from Hackberry galls by John Riemann, a graduate student at the University of Texas, and several small series collected by John Moser of Cornell University, in the vicinity of Columbus, Ohio and Ithaca, New York. Since both men wish to publish on the biology and host relationships of the parasites, descriptions and a key to the four new species follow.

Key to the females of the new species of the genus *Eurytoma* from Hackberry galls

1. Clypeus yellow and often frons below base of scape yellow; post marginal vein one-half the length of the marginal or less. 2
   Clypeus and frons black or frons only may show a reddish-brown tinge below base of scape; post marginal vein more than half the length of the marginal. 3
2. Medium sized species aver. 2.9 mm. (2.5-3.2) in length; 9th abdominal segment elongate and pointed, aver. .22 mm. (.20-.25) in length; hind coxae black at least on lateral surface. ..... *flavovultus*
   Small species, aver. 1.9 mm. (1.6-2.2) in length; 9th segment elongate and pointed but aver. .14 mm. (.10-.17) in length; hind coxae often all yellow. ..... *semivenae*
3. Small species aver. 1.6 mm. (1.3-1.9) in length; abdomen black; face shagreened and lacking umbilicate punctures. ..... *levivultus*
   Medium sized species aver. 2.8 mm. (2.6-3.4); abdomen with lateral surface reddish-brown, sometimes extending over dorsal surface of segments 6, 7 and 8; face with umbilicate punctures. ..... *celtigalla*

Eurytoma flavovultus n. sp.

FEMALE. Mostly black. Aver. in length 2.9 mm. (2.5-3.3). Abdomen black; aver. 1.7 mm. (1.5-1.9) in length; narrowly oval from a lateral view and longer than thorax plus head; sixth segment wider than third, fourth and fifth combined; sixth finely sculptured on lower half of lateral surface; ninth segment elongate and pointed, aver. .22 mm. (.20-.25) in length; white pile absent on the sixth; a few (1-3) on dorso-lateral aspect of the narrow seventh, and covering posterior one-half of eighth. Internal genitalia aver. 1.5 mm. (1.4-1.6) in length and .88 mm. in height; thus length is about 1.7 times height; dorsal valves narrow and with black infuscation limited to horizontal length only; dorsal and ventral valves turn dorsally anteriorly at slightly less than a right angle; stylet arch in an oblique plane; fulcral plate with two chitinous teeth or tubercles on proximal end that

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articulate with the dorsal extensions of the dorsal and ventral valves plus a third distinct tubercle between them. Thorax with the tegulae yellow. Propodeum wide and shallowly depressed; median furrow lacking or indicated by short widely spaced lateral carinae in upper one-third only; most of the surface covered with fine, evenly spaced punctations that may fade out dorsally into two smooth shiny oval areas. Head with vertex and frons covered with closely spaced umbilicate punctures; face covered with short white pile; area surrounding clypeus and lower frons yellow to yellowish-brown; rest black. Antennae with the scape and flagellum yellow; first funicle joint only a little longer than pedicle; funicle joints moniliform, longer than wide; last three closely fused forming a terminal unit; legs yellow, including most often fore and middle coxae; hind coxae black or with some yellow on medial surface; fore coxae in a few with a black smudge on upper part of lateral surface; hind femora may show brown infuscation on the middle of outer surface. Wing veins light yellow; linear, post marginal aver. .12 mm. (.10-.15) and marginal aver. .29 mm. (.25-.32) in length; thus the postmarginal averages less than half the length of the marginal.

MALE. Aver. in length 2.1 mm. (1.9-2.3); black, except for yellow fore and middle legs, middle coxae, tegulae, scape of antennae and area surrounding clypeus. Hind femurs most often dark brown, with yellow knees and apices; hind tibiae, yellow; hind coxae black to dark brown except yellow medial surface; fore coxae often black to dark brown for upper one-half of lateral surface. Antennae with flagellum brown; funicle consisting of only four pedicellate, dorsally humped segments that are only slightly longer than wide; terminal unit consisting of three closely fused segments with the proximal one set off from the middle unit by a distinct but shallow annulation. Wing vein relationships as in the female.

Types: 64 females and 25 males. Holotype female and allotype male in the Bugbee collection, Allegheny College, Meadville, Pa. Paratypes in the U.S. National Museum, University of Texas and Cornell University.

Type locality: Austin, Texas, collected by J. Riemann in October and December, 1953; January and February, 1954; February, 1955; June and September, 1956.

Host: Hackberry galls produced by *Pachypsylla venusta* Osten Sacken, on *Celtis reticulata.*

Additional localities: Texas: Sequin, Feb. 12, 1956, from *P. venusta* on *Celtis* sp., J. Riemann, 2 females and 2 males; Dunn, Jan. 1, 1956, from *P. venusta* on *Celtis reticulata,* J. Riemann, 2 females; Ceta Glen Camp, Randall Co., Dec. 26, 1955 and Apr. 26, 1956, from *P. venusta* on *Celtis reticulata,* 5 females and 2 males; Zorn, Feb. 12, 1956, from *P. venusta* on *Celtis* sp., J. Riemann, 1 male; New Braunfels, Feb. 12, 1956, *P. venusta* on *Celtis* sp., J. Riemann, 7 females and 2 males; LaGrange, May 10, 1956, from *P. venusta* on *Celtis levigata,* J. Riemann, 1 female and 2 males; Plum Creek, Sept. 29, ?, from *P. venusta,* J. Riemann, 2 females and 1 male; Dallas, 1954, from *P. venusta,* J. Moser, 1 female and 3 males; Fort Davis, Aug. 1, 1955, from leaves of *Celtis reticulata,* J. N. Knull, 3 females and 1 male.

Range: Known only from several localities in south central Texas and four additional widely scattered localities further north and west within the state.

Included in the series of specimens sent to me by J. Riemann, collected in Texas, is a single female, bred from a hackberry stem gall believed to be inhabited by *Pachypsylla celtidis inteneris* Mally, from Austin, Texas. The specimen in most of its characteristics resembles *E. flavovultus* closely except for the propodeum. The single female has a distinct, complete, wide and shallow median furrow whose surface is evenly punctate and the lateral areas are covered with deep, irregular pits. One specimen is not enough on which to base any kind of recognition. A suitable series of specimens from *P. c. inteneris* might lead to the separation of this eurytomid parasite as a new species or subspecies of *E. flavovultus.*

E. flavovultus resembles the succeeding species but runs considerably larger in all its measurements; shows black infuscation on the horizontal length of the dorsal valves; has three tubercles on the proximal end of the fulcral plate and occurs on a different host, *Pachypsylla venusta.*

Eurytoma semivenae n. sp.

FEMALE. Small species; aver. in length 1.9 mm. (1.6-2.2); mostly black. Abdomen narrowly oval from a lateral view; aver. in length 1.1 mm. (1.0-1.2); sixth segment wider than third, fourth and fifth combined, its lateral surface covered with fine shallow sculpturing that fades out dorsally; ventrally segments yellowish-brown, often extending dorsally about half-way on segments 7 and 8; ninth segment short and pointed; aver. .14 mm. (.10-.17) in length. Internal genitalia aver. in length 1.0 mm. (.95-1.1) and in height .52 mm. (.50-.57); dorsal valves narrow for horizontal length and without any black infuscation except distal tip; dorsal and ventral valves turn dorsally, anteriorly at less than a right angle; stylet arch about half-way between a horizontal and a vertical plane; fulcral plate with only two tubercles on proximal end, the dorsal one articulating with the dorsal extension of the ventral valves and the ventral one articulating with the dorsal extension of the dorsal valves. Thorax with the tegulae yellow; propodeum broad, shallowly depressed; surface covered with even punctations that may fade out dorsally into a smooth shiny surface; no median furrow, or indicated by short lateral carinae in upper one-third only. Antennae with scape and flagellum yellow; segments of funicle moniliform, longer than wide and terminal unit consisting of three closely fused segments. Head with the clypeus and often the frons to base of scape, yellowish brown; legs yellow and often all coxae; hind coxae may show some black on outer dorsal surface. Wing veins yellow; marginal aver. .22 mm. (.21-.25) in length and the short, stocky postmarginal aver. .09 mm. (.07-.10).

MALE. Aver. 1.6 mm. (1.5-1.8) in length. Mostly black, except for yellow legs including fore and middle coxae, scape of antennae, tegulae, clypeus and lower part of frons. Hind coxae may be mostly yellow or show varying amounts of black infuscation dorsally on lateral and posterior surfaces. Funicle segments brown above shading to yellow below; four petiolate

segments, each about twice as long as wide; terminal unit of three closely fused segments. Wing veins yellow; marginal aver. .23 mm. (.22-.25) and post marginal aver. .10 mm. (.09-.12).

Types: 5 females and 8 males. Holotype female in the Bugbee collection, Allegheny College, Meadville, Pa. Paratypes in the U.S. National Museum, Washington, D.C., University of Texas, Austin, Texas, and Cornell University, Ithaca, New York.

Type locality: Palo Duro Canyon, Texas. Collected Dec. 26, 1955, by J. Riemann.

Host: Bred from galls of *Pachypsylla vesicula* Riley on *Celtis reticulata.*

Additional localities: Texas: Benjamin, Sept. 1, 1955, J. Riemann, from *P. vesicula* on *Celtis reticulata,* 5 females and 2 males; Lubbock, Buffalo Lakes, Jan. 1, 1956, J. Riemann, from *P. celtidis-vesicula* on *C. reticulata,* 1 female and 4 males; Floresville, Feb. 12, 1956, J. Riemann, from *P. c. vesicula* on *C.* sp., 2 females and 3 males; New Braunfels, Feb. 12, 1956, J. Riemann, from *P. c.-vesicula* on *C.* sp., 1 male; Alpine, Brewster Co., Aug. 18, 1955, J. Riemann, from *P. vesicula* on *C. reticulata,* 1 male; Dunn, Sept. 17, 1955, J. Riemann, from *P. vesicula* on *C. reticulata,* 3 females and 2 males; Palmetto Springs, Nov. 1955, J. Riemann, from *P. vesicula* on *C.* sp., 1 male; Blanco R., Feb. 11, 1956, J. Riemann, from *P. c. vesicula* on *C. mississippiensis,* 2 females and 1 male; Georgetown, Aug. 31, 1955, J. Riemann, from *P. vesicula* on *C. mississippiensis,* 2 males; Guthrie, Sept. 1, 1955, J. Riemann from *P. vesicula* on *C. reticulata,* 2 males; Austin, Sept. 26 and Nov. 1, 1955, J. Riemann, from *P. vesicula* and Blister gall on *C.* sp., 6 females and 4 males. Ohio: Columbus, Sept., 1955, J. Moser, from *P. vesicula,* 12 females and 4 males. Kansas: Manhattan, Sept. 25, 1956, R. Smith, from *P. mamma* on *C. occidentalis,* 1 female. New York: Ithaca, Sept. 1956, J. Moser, from *P. mamma,* on *C. occidentalis,* 2 females and 1 male; from *P. vesicula* on *C. occidentalis,* 1 male. Arkansas: Fayetteville, Sept. 25, 1956, D. Moore, from *P. vesicula* on *C. occidentalis,* 1 female and 1 male.

Range: Apparently widespread from New York westward to Kansas and south to Texas.

This species, as pointed out in the discussion following the preceding species, runs smaller than *E. flavovultus.* In addition it occurs on a different host; the narrow dorsal valves are yellowish brown for their horizontal length except distal tip; it displays only two tubercles on the proximal end of the fulcral plate and the coxae are usually all yellow.

Eurytoma levivultus n. sp.

FEMALE. Mostly black. Small species aver. 1.6 mm. (1.3-1.9) in length. Abdomen small, oval in shape and black; aver. .80 mm. (.70-.96) in length; sixth segment wider than third, fourth and fifth combined and lateral surface covered by fine sculpturing that plays out dorsally; ninth segment short and blunt; aver. .08 mm. (.07-.10) in length. Internal genitalia aver. in length .80 mm. and in height .40 mm.; dorsal valves narrow and with black infuscation for horizontal length including distal tip; stylet arch in an oblique plane; one large dorsal and two small ventral tubercles on proximal end of fulcral plate. Tegulae yellowish-brown. Propodeum with a broad almost

flat surface that is finely and evenly punctate ventrally, fading out to a smooth, shiny surface dorsally between lateral carinae; median furrow indicated by two short, widely spaced lateral carinae in upper one-third. Umbilicate punctures on pronotum, occiput and vertex of head, often reduced on the latter to very shallow depressions or may be absent entirely; face black, without umbilicate punctures, finely shagreened and with sparse, short, white pile. Antennae with yellow scape and yellow to yellowish brown flagella; pedicle and first funicle joint about equal in length; funicle segments longer than wide and moniliform. Legs with black infuscation on all femora or middle and hind femora only; tibiae yellow; coxae mostly black, occasionally hind coxae only. Wing veins yellowish brown and linear; short, stocky post-marginal vein aver. .10 mm. (.07-.12) in length and marginal aver. .20 mm. (.17-.25).

MALE. Small, aver. 1.0 mm. (.85-1.2). Mostly black except for brownish yellow scape and flagellum of antennae; light yellow legs with brown infuscation on hind femora and often on middle femora and occasionally on hind tibiae also; coxae may be yellow or mostly brown to black. Sculpturing on pronotum, top of head and face as in the female.

Types: 7 females and 3 males. Holotype in the Bugbee collection, Allegheny College, Meadville, Pa. Paratypes in the U.S. National Museum. Washington, D.C. and Cornell University, Ithaca, New York.

Type locality: Columbus, Ohio, collected June, 1955 by J. Moser.

Host: Reared from *Pachypsylla gemma* Riley.

Range: Known so far only from Columbus, Ohio.

This species, with its reduced sculpturing on the head, lack of yellowish brown coloration of the clypeus and the frons, and black infuscation on the femurs and coxae, can be distinguished from the other species described herein.

Eurytoma celtigalla n. sp.

FEMALE. Aver. in length 2.8 mm. (2.6-3.4). Head and thorax black except reddish-brown tinge to lateral aspect of pronotum and frons below base of scape in a few; abdomen mostly reddish-brown or with black infuscation on dorsal and upper lateral surface of segments 3, 4 and 5 and less often of 6, 7 and 8. Abdomen oval from a lateral view; sixth segment wide, equal to segments 4 and 5 combined from a dorsal view; sculpturing limited to lower half of segment 6; dorsal surface smooth and shiny; ninth segment short but sharply pointed; aver. in length .16 mm. (.12-.20). Internal genitalia with broad, reddish-brown dorsal valves for horizontal length, or some black infuscation distally; dorsal and ventral valves turn dorsally, anteriorly at approximately a right angle and stylet arch in an oblique plane but closer to a vertical rather than a horizontal plane; only one large dorsal and one small ventral tubercle on proximal end of fulcral plate; whole structure aver. 1.5 mm. in length and 1.0 mm. in height. Thorax with the tegulae yellowish-brown. Propodeum wide, shallowly depressed with a distinct median furrow; wide at top and narrowing ventrally; furrow outlined by light but distinct lateral carinae to base; median carina may extend half to three-quarters length of furrow, dividing furrow into small rec-

tangles or squares; areas lateral to furrow, finely punctate, except for row of large five-sided pits extending ventro-laterally across top of lateral areas. Pronotum approximately twice as long as wide. Antennae filiform; yellow scape and flagellum; funicle segments longer than wide. Legs including all coxae yellow to yellowish brown. Wing veins yellow; marginal wider than post marginal; marginal aver. .25 mm. and post marginal aver. .20 mm. in length; thus the length of the postmarginal is about 80% of the marginal.

MALE. Aver. in length 2.1 mm. (2.0-2.3). Black except for reddish brown to yellow legs including fore and middle coxae, tegulae, scape and wing veins; hind coxae may show black infuscation dorsally on medial and lateral surfaces. Flagellum of antennae black and consisting of five longer than wide, pedicellate, dorsally raised segments; terminal unit of two closely fused segments. Marginal vein of the fore-wing aver. .22 mm. and post marginal aver. .19 mm. in length.

Types: 5 females and 6 males. Holotype in the Bugbee collection, Allegheny College, Meadville, Pa. Paratypes in the U.S. National Museum, Washington, D.C., University of Texas, Austin and Cornell University, Ithaca, N.Y.

Type locality: Buda, Texas. Collected June and Aug. 13, 1955; Feb. 14 and March 7, 1956, by J. Riemann.

Host: Phytophaga celtiphylla Felt? on *Celtis* sp., *C. mississippiensis* and *C. laevigata.*

Additional localities: Texas: Austin, Feb. 23, 1955, J. Riemann, from *Celtis* berry gall, 1 male; Aug. 25, 1955, J. Riemann, from *P. celtiphylla?,* 1 male; Pecan Bayou, June 3, 1955, J. Riemann, from *P. celtiphylla?,* 1 male.

Range: Known only from central Texas.

This species is easily told from the preceding species occurring on Hackberry by the reddish brown coloration of the abdomen, the different configuration of the propodeum and the longer postmarginal vein in relation to the marginal.

The affinities of this species appear to be closer to *E. juniperinus* Marco. than to the other three species from Hackberry galls. However, the almost complete lack of color on the clypeus and frons, the complete median furrow of the propodeum and the fact that the first funicle joint is clearly longer than the pedicle will distinguish this new species from *E. juniperinus.*

A DISTRIBUTIONAL CHECK-LIST OF THE FLEAS OF NEBRASKA

WILLIAM F. RAPP, JR.[1] AND DORIS B. GATES[2]

To date there has been only one paper published on fleas of Nebraska (Gates 1945:10-13). Gates in 1947 prepared a thesis for the University of Nebraska entitled: "The Siphonaptera of Nebraska and Their Economic

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Importance." This work has never been published and the records are reported in this paper.

Nebraska, being a state located in the central part of the North American continent, is a meeting place of eastern and western species. If there is an area where eastern and western species intergrade we have not done sufficient collecting to determine it. Nebraska may be divided into four well marked ecological regions. The deciduous forests are located along the eastern border of the state and along the larger rivers. The prairie region is readily divided into the Tall Grass Prairie of the east and the Short Grass Prairie of the west. Many ecologists call the ecotone between the Short and Tall Grass Prairies the Mixed Prairie and recognize it as a distinct area. In the northwest corner of the state is the Pine Ridge which is a region where Western Yellow Pine predominates. All of these areas have mammals which are unique to them, with the result that Nebraska should have a large flea fauna.

This checklist should be regarded as preliminary because we have collected in only a few areas in each ecological region. We feel that more collecting should be done in order to increase our knowledge of Nebraska's fleas.

Sylvatic plague has not been found in Nebraska; however, several adjoining counties in Wyoming and Kansas have a well-known history of it. Therefore, a constant vigilance should be maintained.

The specimens upon which the following records are based are deposited in the collections of the Nebraska State Department of Health, Division of Sanitation, and the University of Nebraska, Department of Entomology.

Order SIPHONAPTERA
Family PULICIDAE
Subfamily SPILOPSYLLINAE

Cediopsylla inaequalis inaequalis (Baker) 1895

Hosts: *Sylvilagus floridanus, Lepus townsendi, Cynomys ludovicianus.* Recorded from: Dawes, Banner, Sheridan, Kimball, Lancaster and Nemaha Counties.

Cediopsylla simplex (Baker) 1895

Hosts: *Sylvilagus floridanus, Lepus townsendi.* Recorded from: Lancaster and Nemaha Counties.

Hoplopsyllus affinis (Baker) 1904

Hosts: *Lynx rufus, Sylvilagus floridanus, Canis latrans, Lepus townsendi.* Recorded from: Morrill, Dawes, Harlan, Lancaster, Frontier, Nemaha, Nuckolls, and Cass Counties.

Subfamily PULICINAE

Pulex irritans Linnaeus 1758

Host: *Lynx rufus, Canis latrans, Canis familiaris, Lepus townsendi, Cynomys ludovicianus, Didelphis virginiana, Mephitis mephitis.* Recorded from: Dawes, Cherry, Sheridan, Lincoln, Colfax, Polk, Cass, Douglas, Lancaster, and Grant Counties.

Subfamily ARCHAEOPSYLLINAE

Ctenocephalides canis (Curtis) 1826

Host: *Canis familiaris*. Recorded from: Thayer County.

Ctenocephalides felis (Bouche) 1835

Host: *Canis familiaris*. Recorded from: Lancaster County.

Subfamily XENOPSYLLINAE

Xenopsylla cheopis (Rothschild) 1903

Host: *Rattus norvegicus*. Recorded from: Adams and Lancaster Counties.

Family HYSTRICHOPSYLLIDAE

Subfamily NEOPSYLLINAE

Catallagia decipiens Rothschild 1915

Host: *Peromyscus leucopus*. Recorded from: Nemaha County.

Epitedia wenmanni (Rothschild) 1904

Hosts: *Peromyscus leucopus, Peromyscus maniculatus, Blarina brevicauda*. Recorded from: Knox, Nemaha, Richardson, Cuming, Furnas, Seward, Otoe, Saline, and Dundy Counties.

Subfamily CTENOPHTHALMINAE

Corrodopsylla curvata curvata (Rothschild) 1915

Host: *Blarina brevicauda*. Recorded from: Knox County.

Ctenophthalmus pseudagyrtes pseudagyrtes Baker 1904

Hosts: *Peromyscus leucopus, Microtus pennsylvanicus, Scalopus aquaticus, Rattus norvegicus*. Recorded from: Furnas, Lancaster, Cass, and Knox Counties.

Subfamily NEARCTOPSYLLINAE

Nearctopsylla genalis genalis (Baker) 1904

Host: *Scalopus aquaticus*. Recorded from: Cass County.

Subfamily RHADINOPSYLLINAE

Rectofrontia fraterna (Baker) 1895

Host: *Microtus pennsylvanicus*. Recorded from: Lancaster County.

Family CERATOPHYLLIDAE

Subfamily CERATOPHYLLINAE

Ceratophyllus celsus celsus (Jordan) 1926

Host: *Petrochelidon albifrons albifrons*. Recorded from: Dawes County.

Foxella ignota ignota (Baker) 1895

Host: *Geomys bursarius*. Recorded from: Washington, Dawes, Burt, Lancaster and Colfax Counties.

Monopsyllus wagneri systaltus (Jordan) 1929

Hosts: *Peromyscus leucopus, Peromyscus maniculatus*. Recorded from: Dawes, Harlan, Nemaha, and Sioux Counties.

Monopsyllus wagneri wagneri (Baker) 1904

Host: *Peromyscus maniculatus*. Recorded from: Dawes, Cherry, Nemaha, Franklin, Cuming, Red Willow, Furnas, Saline, and Dundy Counties.

Nosopsyllus fasciatus (Bosc) 1801

Host: *Rattus norvegicus*. Recorded from: Box Butte, Dawes, and Deuel Counties.

Opisocrostis bruneri (Baker) 1895

Host: *Citellus tridecemlineatus*. Recorded from: Dawes and Lancaster Counties.

Opisocrostis hirsutus (Baker) 1895

Hosts: *Lepus townsendi, Cynomys ludovicianus*. Recorded from: Blaine, Lincoln, Dawes, Cherry, Thomas, Banner, Harlan, Hooker, and Cheyenne Counties.

Opisocrostis tuberculatus tuberculatus (Baker) 1904

Host: *Cynomys ludovicianus*. Recorded from: Dawes, Cheyenne, and Kimball Counties.

Orchopeas howardii (Baker) 1895

Hosts: *Sciurus niger, Didelphis virginiana, Sylvilagus floridanus*. Recorded from: Wayne, Dakota, Lancaster, and Lincoln Counties.

Orchopeas howardii texensis Eads 1950

Host: *Sciurus niger*. Recorded from: Dakota, Dodge, Douglas, and Jefferson Counties.

Orchopeas leucopus (Baker) 1904

Host: *Blarina brevicauda, Microtus ochrogaster, Peromyscus leucopus, Peromyscus maniculatus, Mus musculus*. Recorded from: Richardson, Dawes, Nemaha, Saline, Otoe, Seward, Sioux, and Lancaster Counties.

Orchopeas sexdentatus (Baker) 1904

Host: *Microtus ochrogaster*. Recorded from: Dawes and Nemaha Counties.

Oropsylla arctomys (Baker) 1904

Host: *Mephitis mephitis*. Recorded from: Keith County.

Thrassis campestris Prince 1944

Host: *Dipodomys ordii*. Recorded from: Grant and Hooker Counties.

Thrassis fotus (Jordan) 1925

Host: *Citellus tridecemlineatus, Rattus norvegicus*. Recorded from: Dawes, Cheyenne, Saline and Box Butte Counties.

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SOME FACTORS AFFECTING THE MALE REPRODUCTIVE SYSTEM IN COCKROACHES (ORTHOPTERA:BLATTIDAE)[1]

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In the process of exploring various endocrine relationships among insects, several workers have made references to the possible existence of sex hormones. Scharrer (1946a) reportd that, in *Leucophaea maderae* (Fab.), removal of the corpora allata from recently molted adults prevented egg maturation in females but did not interfere with sperm production in males. Her conclusion was that the corpora allata are apparently not necessary for reproductive activity of adult males but are required for egg production in females. Wigglesworth (1936), Pfeiffer (1945), Thomsen (1940, 1948), and others have arrived at similar conclusions about different insects. However, it was reported by Snodgrass (1937) that the sperm of *Blatta orientalis* L., is already mature in the last nymphal instar and that the testes begin to deteriorate soon after the external adult characteristics are attained.

To see if this early development occurs in other species of cockroaches, including *L. maderae,* the time and sequence of spermatogenesis was investigated. Testes were removed from male nymphs in the last and various earlier instars. Each such organ was placed in a drop of saline on a microscope slide, crushed under a clean cover slip, and observed with a phase microscope. In some cases only one testis was removed, the other was left in place for removal and observation of subsequent development in a later instar. These operations, the mechanics of which varied somewhat with the different species, had no ill effects on the specimens. Penicillin[4] in saline was used on the wounds to prevent infections.

Live motile sperm, which were identical in appearance and activity with those of adults, were found in the last instar nymphs of the following species: *Blatta orientalis* L., *Eurycotis floridana* (Walker), *Periplaneta americana* (L.), *Blattella germanica* L., *Supella supellectilium* (Serv.), *Parcoblatta* sp., *Blaberus giganteus* (L.), *Leucophaea maderae* (Fab.), and *Diploptera dytiscoides* (Serv.).

It is evident, therefore, that removal of the corpora allata from *adult* male cockroaches, at least from those species listed above, would not affect the appearance of sperm. Scharrer's work (1946a) indicates, also, that these endocrine glands are not necessary to maintain the sperm after they

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[2] Portion of dissertation presented as partial fulfillment of the requirement for the degree Doctor of Philosophy in Entomology at Kansas State College.

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[4] Supplied by Professor Dean Folse, Department of Veterinary Medicine, Kansas Agricultural Experiment Station.

are produced. This was borne out by the writers' work with *Leucophaea* and also with *P. americana.*

The next and logical step was to remove the corpora allata during the nymphal instar preceding that in which motile sperm are first produced. However, allatectomies performed in the penultimate or earlier instars give rise to "adultoid" or "preadultoid" forms (Scharrer, 1946). Such individuals result from the passing over and elimination of intervening instars and the precocious appearance of adult or adult-like external characteristics.

Male *Leucophaea* ranging in age from fourth through eighth instar were allatectomized before the "critical period" (Scharrer, 1946). No effects of allatectomy were visible externally when operated last-stage nymphs molted to adult; however, successfully allatectomized younger instars gave rise to adultoids at the next molt. In this study, no preadultoids, such as were reported by Scharrer (1946), were produced. All adultoids had adult color and texture of the cuticle and inflated wing pads with at least some differentiation of the notal wing processes and axillary sclerites.

All adultoids showed precocial development of sperm. Males allatectomized in the sixth and seventh instars had live motile sperm at the time of the molt to the adultoid state. Males allatectomized in the fourth and fifth instars showed no precocial development at the time of the adultoid molt but within thirty days after molting had live motile sperm. These were compared with operated and unoperated controls. In all cases sperm development in adultoids was far beyond that attained by the controls.

Seventh and eighth instar allatectomized nymphs had accessory glands which appeared normal in size and development at the next molt. Younger operated forms had, at the next molt, varying degrees of development of the accessory glands corresponding to the degree of adultoid body development. However, in none of the allatectomized males were the glands actively secreting. None of the controls or allatectomy failures showed this effect, which to some extent provided a check on the success of the operation. Also, the prothoracic glands were degenerate in all adultoid cockroaches when, at the end of the experimental periods, they and all the controls were dissected for a final check on various organs and glands.

It is evident that the presence of the corpora allata has an inhibitory effect on spermatogenesis. In the absence of these glands, both primary and secondary sex characters appear at the next molt. The corpora allata then cannot be the site of elaboration of a sex hormone. This lends further credence to the theory of a "juvenile hormone" elaborated by the corpora allata.

As the investigations outlined above were being carried out, it became increasingly apparent that possible endocrine activity of the testes and accessory reproductive structures should be investigated. Nymphs of both *Periplaneta americana* (L.) and *L. maderae* (Fab.) were used in the succeeding experiments.

The accessory gland bud is located ventrally on the cockroach between the cercal nerves and caudal to the last abdominal ganglion. The operation was relatively simple; the eighth sternite was lifted upward and forward, an

incision was made in the eighth-ninth intersegmental membrane and the buds were lifted out. The eighth sternite was pushed back into place and the subject caged for further development and observation. In three cases the phallomeres were extirpated along with the accessory gland buds. These operations were performed on males in the last three nymphal instars; all operated individuals were allowed to develop to the adult stage.

Except for scars on the eighth sternite, removal of the accessory gland buds produced no observable effects other than the absence of the corresponding glands in the adult. Genitalia and testes developed normally and the usual quantity of mature, motile sperm was found. Removal of phallomere buds resulted in adult males without external genitalia. In all cases the insects were, except for the parts removed experimentally, exactly like the check individuals.

Castration experiments were started on both species listed above. However, the testes of *P. americana* are elongate, irregular in shape, and imbedded in the fat of the abdominal region. Because of the difficulty of removing all of each testis and the danger of excessive damage to the abdominal region and contents, this species was abandoned. The testes of *L. maderae*, on the other hand, are distinctly globular in shape and lie free on either side of the body cavity on long stalks, the vasa deferentia. The operation was simple and complete removal was easily assured. For these reasons all gonadectomy experiments were performed with *L. maderae* nymphs.

Testes were exposed by cutting into the seventh sternite near the dorsoventral muscle bundle on either side and lifting back the outer fragment thus produced. Slight pressure forced the testes into the opening and they were then broken from the stalks. In some cases both testes were removed; in others, only one. Ovaries were removed from female nymphs in the same manner. The displaced sternal fragments were restored and the entire area was treated with penicillin in saline. These gonadectomies also were performed on nymphs of the sixth, seventh, and eighth nymphal instars, which subsequently developed into the adult stage. Except for the absence of the gonads, these operations produced no observable effects on the operated insects.

SUMMARY

1. Mature sperm are present in the last nymphal instar of nine common species of cockroaches; allatectomy in the adult male then does not prevent sperm formation and does not preclude a possible interaction between corpora allata and testes.

2. Allatectomy in the proper instar results in the formation of adultoids in which, on a time basis, sperm production is far ahead of that of normal or operated controls.

3. The corpora allata, therefore, are not necessary for the formation of sperm by the male; conversely their presence exerts an inhibitory effect on spermatogenesis.

4. The corpora allata cannot logically be the site of elaboration of a sex hormone since development of both primary and secondary sex characteristics proceeds rapidly in its absence.

5. Since removal of the accessory gland buds and/or phallomeres resulted in adults not otherwise deformed, these structures apparently exert little or no hormonal influence.

6. Gonadectomy in either sex produced no evident external changes; these structures, likewise, exert no apparent hormonal influence on the insect.

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A NEW SPECIES OF *BAETIS* FROM OREGON (Ephemeroptera: Baetidae)

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Baetis caurinus new species

Baetis sp. Allen and Edmunds. Proc. Utah Acad. Sci., Arts and Letters 33:86.

MALE IMAGO (in alcohol). Length: body 5-6 mm., wings 5-6 mm. Head (fig. 2) medium brown; antennae pale; ocelli ringed basally with black; lower portion of eyes black; turbinate portion of eyes orange on upper surface and pinkish orange on sides, stalks moderately long, pale and somewhat translucent; turbinate portion of eyes medium sized and elongate-oval from above. Thorax yellowish-brown; dorsum of apex of mesoscutellum pale, sides medium brown. Pleurae yellow-brown, with episterna medium brown. Sternum medium brown with pale areas betwen sclerites. Legs pale, forefemora with a narrow longitudinal faint purplish trachea running from base to apex. Wings hyaline; venation pale, translucent; base of C and Sc brown; stigmatic area clouded; stigmatic crossveins anastomosed. Hind wing (fig. 1) with well developed costal projection, three longitudinal veins and no intercalaries. Abdominal segments 1-6 hyaline, with faint narrow purplish transverse lines across the mesal half of the apical margins of the tergites; longitudinal tracheal trunks on lateral line, spiracles, and bases of main dorsal and ventral branches of trachea of segments 1-6 purplish; abdominal segments 7-10 opaque, light yellow-brown. Genital forceps of the *intercalaris*-type (fig. 3). Cerci pale, translucent.

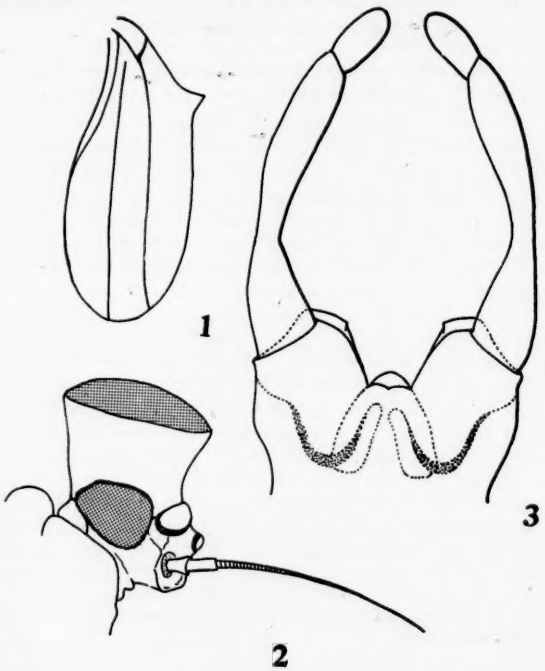
[1] The research on which this report is based was supported by grants from the University of Utah Research Fund.

Holotype: Male imago, Alsea River near Oregon State Highway 34, 10 miles west of Alsea, Lincoln County, Oregon, 25-VIII-54, G. F. Edmunds, Jr. and Richard K. Allen, in collection of the University of Utah. Paratopotypes: 46 male imagoes; 1 male each in collections of W. C. Day, California Academy of Sciences, J. R. Traver, and Canadian National Collection; 42 males in University of Utah collection.

TAXONOMY

Baetis caurinus is the seventh species of this genus with *intercalaris*-type genital forceps to be described from western North America. In Traver's key (1935. The biology of mayflies.), *Baetis caurinus* keys to *B. phoebus* McDunnough, an eastern species described from Ontario. *Baetis caurinus* may be distinguished from all other known species of this genus with *intercalaris*-type genital forceps by the coloration on the abdominal segments, in which abdominal segments 1-6 are hyaline, with narrow purplish lines near their apical margins, and purplish longitudinal tracheal trunks on the lateral line. The female imago and the nymph of this species are unknown.

The specimens were collected swarming over the highway near the Alsea River at dusk in a fine drizzle of rain. This locality is in the Coast Range at an elevation of approximately 200 feet.



EXPLANATION OF FIGURES

Figs. 1-3. *Baetis caurinus*, male imago, paratype. Fig. 1. hind wing. Fig. 2. lateral view of head. Fig. 3. ventral view of male genitalia.

OVIPOSITION RESPONSE OF THE CORN EARWORM TO DIFFERENCES IN SURFACE TEXTURE[1]

PHILIP S. CALLAHAN[2]

The corn earworm, *Heliothis zea* (Boddie), arches the abdomen downward and forward while ovipositing and simultaneously pulls the thorax away from the surface on which it rests. The slightly extended legs are hooked to the surface by the claws. Although the imagos can crawl up glass or plastic surfaces with the aid of wings, they do not ordinarily rest on such surfaces. Eggs are deposited on the floor of waxed ice cream cartons and rarely on the sides.

Chemical stimuli are probably the attracting factors among different plants, but tactile perception of the proper surface for oviposition determines where the eggs are laid. This is demonstrated in the confines of a cage where villous cloth was chosen over most plant leaves and even corn silk (Callahan, 1956). Ditman and Cory (1933) showed that the upper villous surface of the corn leaves received 21.6 per cent of the total eggs while the lower glabrate surface received only 8.1 per cent. McColloch (1920) stated that the upper and lower corn leaf surfaces received 32.7 and 9.5 per cent of the eggs respectively. Since the female prefers to deposit eggs on cloth rather than on leaves, wood, wax paper, or other surfaces, it seems logical to believe that the character of the surface is a factor in determining where eggs will be deposited. The objective of this work was to study the oviposition response of the corn earworm to differences in surface texture.

Surfaces chosen for this experiment were either artificial or were the leaf surfaces of host plants of the larvae. One exception was the *Physalis* sp. which is the host plant of *Heliothis subflexa* (Gn.), a related species (Brazzel et al., 1953). The surfaces were first observed under a binocular scope to determine their characteristics. The following are descriptions of the 17 surfaces tested:

1. Cotton sack cloth	30 tangled hairs per square mm. of surface, loosely woven. VILLOUS
2. Cotton percale	30 tangled hairs per square mm. of surface, more closely woven than sack cloth. VILLOUS
3. Alfalfa	Small leaves and flowers; leaves about 14 mm. by 5 mm., tops of leaves completely covered by long, fine hairs lying parallel to leaf surface, bottoms of leaves hairless but punctate, midribs

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	with about 9 long hairs per 1 mm. of length, about 14 long hairs per square mm. of top surface, flower buds extremely hairy. VILLOUS
4. Balsa wood	Made up of parallel rigid cellulose fibers, very irregular surface. More like veins of a leaf than hairs.
5. Colombia II, top	Long, strong hairs, but flexible and about 1 mm. in length, 1-3 hairs every square mm. of surface. VILLOUS
6. Corn silk	Oblong shape with from 6-10 short, fine hairs on either side, about 20 per 1 mm. length of silk.
7. Soybean leaf, bottom	Same type of hairs as on top, only more; about 14 per square mm. of surface; the veins more protruding and with 15 or so hairs along 1 mm. of length, none of these hairs as long as those on the top of the leaf. PILOSE
8. Tomato leaf, top	Long hairs on midrib varying in length from ½ mm. to 1¼ mm. in length, about 15 per 1 mm. of length; 25 short, stiff hairs per square mm. of surface, differing from the bottom in the presence of some scattered long, flexible hairs. STRIGOSE
9. Soybean leaf, top	Very fine, long, straight hairs about 1 mm. in length but not tapered as in hairs on corn leaf, about 10 to each square mm. of surface; hairs on veins same but up to 1¼ mm. long. PILOSE
10. Tomato leaf, bottom	Coarse, heavy leaf, covered with thick curled barbs, about 80 per square mm. of leaf; veins large, about 40 barbs along each 1 mm. of vein. STRIGOSE
11. K1859, top	Same hairs as on Colombia II but only 1 every 3 square mm. of surface; hairs also slightly finer and more flexible than on Colombia II. VILLOUS
12. *Physalis* sp., top	Pebbled, 1 spurlike hair every 2 mm. of surface. HIRSUTE
13. *Physalis* sp., bottom	Slightly pebbled, large, well-defined ribs, hairless.
14. Sorghum leaf, top	No hairs. GLABRATE
15. K1859, bottom	No hairs. GLABRATE
16. Colombia II, bottom	No hairs. GLABRATE
17. Sorghum leaf, bottom	No hairs, leaf with only slight parallel veins on bottom, slight relief. GLABRATE

METHODS. Preliminary experiments were conducted with a newly emerged female moth held in position by a holder. One gram sections of

leaf and other substances were used. Both sides of the leaves were graded as to hairiness, both on the surface and on the ribs. The moth was placed on the surface and then lifted for five seconds five different times. The ability to cling was graded on the ease with which the moth maintained its hold on the surface and on the number of lifts.

On every leaf surface tested, the moth sought to find a well defined rib in which to hook the claws. Where veins were absent or too far apart for the expansion of the moth's legs, the claws hooked to the hairy covering of the leaves. When the claws were hooked to well defined ribs or on corn silks, the moth could retain in its grasp the gram of weight for indefinite periods. One moth thus held a cotton leaf for three days, drinking drops of water placed on the leaf surface. The structure of the pretarsus and claw is shown in Fig. 1.

FIG. 1. Ventrolateral view of the hind pretarsus of the imago. The two-toothed lateral claws and arolium are shown.

Preliminary results indicated that the moths could maintain the leaves in their grasp, without the use of ribs, on surfaces that were villous. On hirsute, strigose, or pilose surfaces they had more difficulty maintaining a hold. On glabrate or canescent surfaces, they could maintain a grasp only with difficulty. Corn silk, although it has puberulent hairs along its edges, should be classed with leaf ribs. On certain plants such as cotton, the insect could cling to one surface and not the other.

A further observation could be drawn from watching the moth climb a rough surface such as wood or paper. Under such conditions the legs were widespread and the tarsi bent parallel with the surface. The spines of the tarsi came in contact with the surface in much the same manner as climbing spikes by a lineman, and served to hold the moth to the surface. In this position, however, the body was so close to the surface that normal oviposition with the arched abdomen and back was difficult. This was indicated by the observation that the moths never oviposited on the wooden sides of the cage although they walked up wood with ease.

Although these preliminary experiments indicated a difference in ability of a moth to cling to a surface, it was apparent that the method used was not objective enough to permit a good rating of the various surfaces. This proved to be the case when two different varieties of corn leaf (K1859 hybrid and Colombia II) were tested. Although there were considerably more hairs on the Colombia variety than on K1859, it was very difficult to ascertain which of the two presented the better surface. Consequently, an apparatus (Figure 2) was designed to test the ability of a moth to cling to a

surface. Each surface was attached to a light round wire frame. A thread passed from the frame around a pulley directly under the imago held in a holder and up over a second pulley. The pulleys in this apparatus served to orient the thread in a straight downward and direct pull from the surface and to eliminate jarring of the imago by the addition of weight. The pulleys further helped to stabilize the surface platform and to eliminate swaying of the threads and tested surfaces. A paper cone was attached to the end of the thread and sugar was poured into the paper cone until the weight

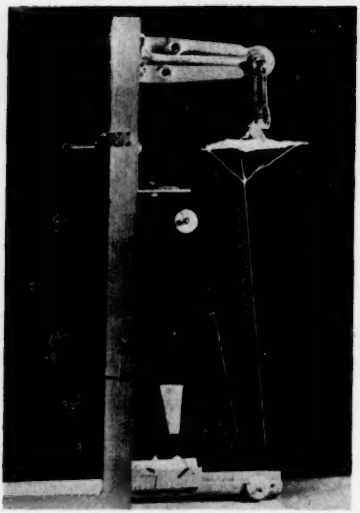

FIG. 2. Apparatus for testing the response of the imago to differences in surface texture.

pulled the surface away from the imago's pretarsi. The surface, thread, and cone with sugar were weighed and the surfaces assigned a rank by weight. Using the apparatus shown in figure 2, one imago was tested three times using each surface. It was found, however, that the imago soon became most uncooperative due to fatigue. Rather than running an imago through 51 tests, three for each surface, better data were obtained by putting three or four fresh imagos through one test. Another species, *Chorizagrotis auxiliaris* (Grote), the army cutworm, was also used for comparison. Although it was heavier than any of the corn earworm imagos used, it seemed to be weaker (Table I).

RESULTS. The data obtained using this method are recorded in Table I. Most of the surfaces in category 1 ranked about the same for each imago. The rankings in category two (2) were not so regular and in category three (3) they were very irregular. These data show that the villous surfaces are best suited to moths for maintaining a foothold. All surfaces in category 1, with the exception of Balsa wood which was hard to classify, had numerous,

long, tough, but not too rigid hairs that were often bent parallel to the surface. Those surfaces in category 2 had fairly distinct ribs and veins which could be grasped, and a hirsute or strigose surface as in tomato leaf or pilose surface as in the case of soybean leaf. Category 3 surfaces were either glabrate or punctate on which the veins were only slightly defined. Trends were similar in the two species of moths.

This mechanical test not only classified surfaces in categories of suitability and distinguished between top and bottom surfaces, but also showed differences between two corn varieties. Colombia 11 always tested higher than K1859. Using this technique plant and plant varieties could be arranged according to the desirability of their surfaces as resting places for *Heliothis zea*.

TABLE I. Weight in grams supported by each of three corn earworm imagos and one army cutworm imago while clinging to various artificial or plant surfaces.

		Corn earworm			Army cutworm
Surface		July 13 239 mg female	Oct. 3 233 mg female	Oct. 4 176 mg male	Oct. 17 278 mg female
Category 1					
Cotton sack		2.563	4.290	2.853	2.246
Cotton percale		2.206	2.896	2.631	1.628
Alfalfa		2.134	2.603	1.976	1.318
Balsa wood		2.080	2.148	1.922	1.518
Colombia II*	(T)**	2.066	2.016	1.786	1.234
Category 2					
Corn silk		1.697	2.009	1.570	1.254
Soybean	(B)**	1.616	1.781	1.588	1.168
Tomato	(T)	1.675	1.732	1.739	1.064
Soybean	(T)	1.595	1.484	1.429	1.038
Tomato	(B)	1.352	1.468	1.318	0.926
K1859 corn	(T)	1.724	1.466	1.250	0.804
Physalis sp.	(T)	.....	1.314	1.164	0.470
Physalis sp.	(B)	.....	1.468	1.145	0.188
Category 3					
Sorghum	(T)	0.862	1.026	0.974	0.724
K1859 corn	(B)	0.803	0.848	0.712	0.234
Colombia II*	(B)	0.790	0.784	0.836	0.288
Sorghum	(B)	0.930	0.570	0.174	0.000

*Corn.
**T = upper side of leaf; B = lower side of leaf.

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WINTER SURVIVAL OF SOUTHWESTERN CORN BORER[1]

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Mortality of overwintering southwestern corn borers (*Zeadiatraea grandiosella* Dyar) can be an important natural control measure. This is evident from the relatively small number of first generation eggs deposited. Physical factors, rain and cold or a combination of both, are presumably responsible for most of the reduction in populations during winter months. Extremely low numbers in the spring of 1955 prompted a comparative examination of past weather records and southwestern corn borer survival.

An average from 11 Arkansas counties revealed a winter survival of only 12 per cent in 1954-55. The lowest temperatures occurred in February and March, months of above normal rainfall (Table I). Many overwintering borers had cleaned out emergence channels by March. Decay had no doubt reduced insulating qualities of the stalks.

In three other winters average survival ranged from 30 to 41 per cent in Arkansas (Rolston 1955). The cobination of low temperatures and above normal precipitation in late winter did not occur during these winters (Table I).

TABLE I. Winter Survival in Relation to Temperature and Rainfall, Fayetteville, Arkansas

	1952-53	1953-54	1954-55	1955-56	1955-56	
Per cent winter survival	37%	30%	12%	41%		
	Departures from normal precipitation				Actual rainfall Fay.	Van Buren
November	+1.52	—1.51	—2.55	—1.62	1.43	1.03
December	—1.50	—0.57	+2.64	—2.24	0.54	0.68
January	—1.14	—0.19	—1.75	—1.67	1.21	1.32
February	—1.35	—1.58	+2.06	+1.90	4.29	5.01
March	+3.54	—1.03	+0.55	—1.60	1.89	2.08
	+1.06	—4.88	+0.95	—4.23	9.36	10.12
Extreme low temperatures in °F.						
November	12	19	17	11		
December	18	5	14	6		
January	9	—4	11	5		
February	14	18	3	18		
March	26	12	9	22		

An attempt was made during the winter of 1955-56 to evaluate the effect of added moisture on winter survival of the southwestern corn borer. In large field plots at Fayetteville, Arkansas, sprinkler irrigation was used to

[1] Published with the permission of the Director of the Arkansas Agricultural Experiment Station.

apply 9 and 4½ inches of water above actual rainfall at the rates of 1½ and 3 inches during December, January, and February (Table II). The plots were approximately ¼ acre in size.

TABLE II. Effect of Moisture Added by Sprinkler Irrigation on Large Field Plots, Fayetteville, Arkansas

9 inches water added per cent survival	4½ inches extra water added per cent survival	Check per cent survival
55	50	50
50	20	—

(Note: Two replications in irrigation treatment. None in check above.)

In another test at Fayetteville stubble was transplanted to 3 ft. × 3 ft. plots and given 9 and 4½ inches of additional water by irrigation through a sprinkler pan at the monthly rates as in the above mentioned test. The 3 ft. × 3 ft. plots each contained 20 girdled stubble[2] and were replicated three times (Table III).

TABLE III. Effects of Moisture Added by Sprinkler Pan to 3 × 3 Plots. Average of 3 Replications, Fayetteville, Arkansas

9 inches water added per cent survival	4½ inches extra water added per cent survival	Check per cent survival
58.4	63.3	43.3

A field test was also conducted at Van Buren, Arkansas, at the Vegetable Substation. Twelve and one-half inches additional water was applied by sprinkler irrigation to one plot at the rate of approximately one inch per week during December, January, and February. Survival was 40% compared to 51% in the check.

In these three tests additional moisture did not reduce the winter survival of southwestern corn borer under the prevailing conditions.

SUMMARY

Winter survival of southwestern corn borers was low one year out of the past four in northwestern Arkansas. Study of weather records suggests that the combination of low temperature and above normal precipitation in late winter accounted for the low survival.

Winter irrigation failed to reduce winter survival in 1955-56. The low temperatures were 5° and 6°F and occurred in December and January.

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[2] Overwintering southwestern corn borers girdle the stalks in the fall prior to going into hibernation, causing complete lodging of nearly all girdled stalks.

MORPHOLOGY OF THE THORACIC SUTURES AND THEIR TAXONOMIC SIGNIFICANCE IN THE GERRIDAE (Hemiptera-Heteroptera)[1]

RYUICHI MATSUDA

During the course of taxonomic studies of the Gerridae, some morphological problems have been encountered which need to be solved before further work is done on this group of insects. The problems involve the sutures that occur on the thorax of wingless forms. A considerable number of difficulties were experienced in working out the problems in this highly specialized family of the Hemiptera-Heteroptera which itself is a highly specialized order of insects. The difficulties arise, first of all, from the extremely high degree of fusion of parts in the thorax; the tergum, the pleuron and the sternum in apterous forms are completely fused in most cases; the pleural suture, which is a good landmark[2] in lower pterygote insects, is no longer recognizable in this family as in many other families of Heteroptera.

In spite of these difficulties, there are still some good landmarks from which we can proceed with our morphological charting on the thoracic surface. The best landmark in defining the mesothorax and metathorax is the metathoracic spiracle which is clearly exposed superficially in most genera of the Gerridae as will be noted in the accompanying figures. I misidentified the spiracle as the lateral scent gland opening in a recent paper (Matsuda, 1956). The thoracic spiracles always have a tendency to be located in the extreme anterior region of the thoracic segment to which they belong in all orders of insects; therefore, the location of the metathoracic spiracle indicates the lateral anterior limit of the metathorax. Another good landmark is the spiracle of the first abdominal segment. The first abdominal spiracle has always escaped the notice of the taxonomists of this family as well as of the workers with other families of Heteroptera, but it is present and recognizable in most species of most genera of the Gerridae. The spiracle is more clearly recognizable in the winged forms, beneath the wing, than in the wingless forms. In some genera of the Gerridae the metanotum and the first abdominal tergite are completely fused. In that case the first abdominal spiracle is a good indicator of the presence of the first abdominal segment. The presence of the first abdominal tergite also often has escaped the notice of taxonomists of this group of insects. For example, Esaki (1927, p. 253) seems to have missed this segment in giving the subfamily character of the Ptilomerinae when he said "The abdomen with six abdominal and two genital segments." Another advantage in making a morphological interpretation of the thoracic sutures in the Gerridae is that the posterior region of the metathorax and the first abdominal segment in

[1] Contribution No. 937, Department of Entomology, University of Kansas. This study was supported by a grant from the National Science Foundation.

[2] Point of structural stability from which we can proceed with our morphological interpretation of the neighboring structures.

winged and wingless forms of the Gerridae are structurally practically the same. This facilitates the interpretation of the thoracic sclerites in this family. With these landmarks in mind the interpretation of the thoracic sutures can be undertaken.

THE INTERSEGMENTAL SUTURE BETWEEN THE MESOTHORAX AND METATHORAX AND THE SECONDARY METATHORACIC SUTURES. Since the metathoracic spiracle is a good landmark indicating the extreme anterolateral limit of the metathorax, and it actually occupies an intersegmental position in most cases, the intersegmental suture between the mesothorax and metathorax is expected to be at or anterior to the spiracle. This situation occurs in *Gerris, Charmatometra, Brachymetra, Potamometra,* etc. Another suture between the meso- and metathorax in some genera is not the intersegmental suture. For instance, in the genus *Rheumatobates* the suture in question goes posterior to the spiracle; therefore this cannot be the intersegmental suture. If this were the intersegmental suture we would have to assume that the spiracle has migrated from one segment to another, i.e., from the metathorax to the mesothorax. This is morphologically highly improbable, if not impossible. The validity of this interpretation is further evidenced by the fact that the hind wing arises from the area far in front of the suture in *Rheumatobates.* The suture in *Rheumatobates,* therefore, is definitely not the intersegmental suture between the meso- and metathorax, but is a secondary suture of the metathorax. The dorsal region anterior to the suture is composite in origin, comprising the mesonotum and a part of the metanotum. The occurrence of the secondary metathoracic suture is noticed in many other genera of the Gerridae; and whenever the secondary metathoracic suture occurs, the primary intersegmental suture is always lost.

The precursor of the secondary suture is suspected to be the short transverse suture arising posterior to the metathoracic spiracle in the genera in which the intersegmental suture is still retained. Evolutionarily speaking, the primary intersegmental suture is apparently being lost. In some genera of the Halobatinae and the Gerrinae and in all genera of the Ptilomerinae the primary intersegmental suture, at least dorsally, is retained, and the distinct secondary metathoracic suture never develops. The primary intersegmental suture is sometimes indistinct in some species of the same genus in which the suture is usually present, and also the suture sometimes completely disappears in some individuals of species in which it is normally distinct (e.g., some *Brachymetra).*

THE COXAL CLEFT. The coxal cleft in the mesothorax goes anteriorly in the acetabular region for a considerable distance and ends as a more or less darkly pigmented area. This darkly pigmented area is the point of articulation of the coxa beneath the pleuron. The pleural suture does not develop beyond this point of articulation.

THE OMPHALIUM AND THE CHANNEL ACROSS THE OMPHALIUM. The omphalium and the channel leading to the lateral opening of the scent gland on the acetabular region is characteristic of the Gerridae, but the lateral opening is sometimes hidden beneath the tuft of hairs as in *Brachymetra.* The ventral omphalium is subject to varying degrees of reduction in

various genera, but the transverse channel across the omphalium, even in case of the complete loss of the omphalium, is retained on the ventral surface of the metathorax in some genera. This transverse channel sometimes looks like an ordinary suture and easily leads to its misinterpretation as the anterior margin of the first ventral abdominal segment. For instance, Lundblad (1933, p. 144) apparently misinterpreted it as the anterior margin of the first ventral abdominal segment in *Rhagadotarsus*. As will be noted from the figure of *Rheumatobates*, a close relative of *Rhagadotarsus*, the channel in question extends laterally onto the metathoracic acetabular region, the region exactly equivalent to the region where the channel ends laterally in *Brachymetra*. It is hardly conceivable that the suture in question represents the anterior margin of the first ventral abdominal segment in this highly specialized genus of the Gerridae. The first ventral abdominal segment, at least externally, is completely lost in all genera of the Gerridae as in most other groups of Hemiptera-Heteroptera.

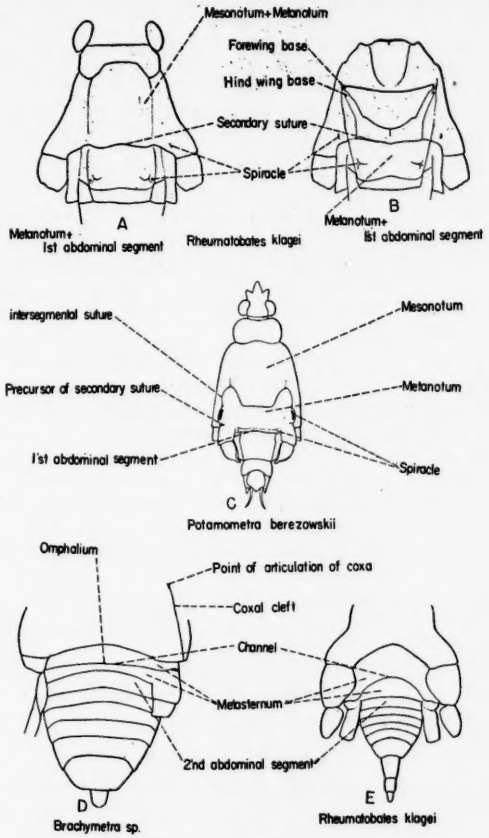
LONGITUDINAL SULCUS IN MESO AND METANOTA. There occurs, in some genera of the Gerridae, a median longitudinal sulcus in the meso- and metanota. This sulcus sometimes can be a good indicator of the presence of the metathoracic element in case the metanotum and the first dorsal abdominal segments are completely fused. The posterior limit of the sulcus indicates the median posterior limit of the metanotum, since the sulcus usually ends at the middle of anterior margin of the first dorsal abdominal segment. A caution, however, should be observed in using this sulcus as the indicator of the metathoracic element, since this suture occasionally extends into the region of the basal abdominal segments in case more than one abdominal segment is fused with the metanotum medially.

SOME COMMENTS UPON THE TAXONOMY OF THE GERRIDAE

The elucidation of the morphological nature of the thoracic sutures presents some important problems in the classification of the higher taxonomic units of the family. It will be noted that in the largest subfamily, Halobatinae, there are three groups, each with distinct types of dorsolateral thoracic sutures, i.e., the group with the intersegmental suture and never with the well developed secondary metathoracic suture and with long pronotum *(Charmatometra* and *Brachymetra);* the group with the intersegmental suture and without a well developed secondary metathoracic suture aside from the precursor or lateral indication of the secondary suture, and with short pronotum *(Ascleopis* and *Amemboa);* and the last group with a distinct secondary metathoracic suture and without the intersegmental suture (many genera such as *Rheumatometra, Noboandelus, Trepobates, Metrobates, Halobates, Halobatopsis, Ovatametra, Telmatometra, Metrobates,* etc.). In the Gerrinae there are two groups, the one with the intersegmental suture represented by *Gerris* and *Limnogonus,* and the group with the distinct secondary metathoracic suture and without the intersegmental suture represented by *Cylindrostethus, Potamobates,* etc. In Rhagadotasinae, two known genera, *Rhagadotarsus* and *Rheumatobates,* have a distinct secondary metathoracic suture instead of the intersegmental suture.

In the Ptilomerinae, the meso- and metathorax are, at least dorsally, clearly separated. Laterally these two segments are often indistinctly separated by the suture. The secondary meathoracic suture never develops.

It should be remembered that one of the primary characters used in the subfamily classification of the Gerridae is the shape of the eyes. The genera with the interiorly emarginated eyes are placed under the Gerrinae, and those without emargination on the inner margins of eyes are placed under



EXPLANATION OF FIGURES

A. *Rheumatobates klagei* Schroeder, wingless form. Dorsal view. B. *Rheumatobates klagei* Schroeder, winged form. Dorsal view. C. *Potamometra berezowskii* Bianchi, wingless form. Dorsal view. D. *Brachymetra* sp. Ventral view. Right middle leg is removed. E. *Rheumatobates klagei* Schroeder. Ventral view.

the Halobatinae. The question now arises which is the more important character for subfamily classification, the eyes or the sutures? I am strongly inclined to believe that the sutures, which appear to indicate stages of evolution, are more important characters than the shape of the eyes, which in my experience may show varying degrees of emargination of the inner edge among genera within the same subfamily. A difficulty may arise in using these sutures as primary characters for subfamily classification due to the fact that the intersegmental suturei s not very stable, as was mentioned previously. In that case the stability of the secondary metathoracic suture—presence or absence of it—and the fact that whenever the secondary suture occurs the intersegmental suture does not occur—may be the primary criterion.

If the idea here expressed is accepted, the subfamily classification of the Gerridae will be subject to a considerable degree of reorganization or at least reconsideration. Many genera now included within the Halobatinae share the same structural pattern with the genera of the Rhagadotarsinae as far as the sutures here in question are concerned. Also *Cylindrostethus,* and *Potamobates,* which are now placed under the Gerrinae, agree with the genera of the Rhagadotarsinae as far as the thoracic sutures are concerned. It seems to me that a certain degree of reshuffling of genera is inevitable within the family if these sutures are taken into serious consideration in the classification of the Gerridae.

On the generic level the sutures also seem to be of taxonomic importance. Although the intersegmental suture between the meso- and metathorax and the secondary metathoracic sutures seem to be more of subfamily importance rather than being subgeneric or generic characters, the varying degrees of fusion of the metanotum with the basal abdominal tergites, varying degrees of reduction of the first abdominal tergite, varying degrees of reduction of the omphalium and the channel leading laterally onto the opening in the acetabulum from it, and presence or absence of the longitudinal sulcus on the meso- and metanota, seem to be characters of subgeneric or generic level. I have discussed previously (1955) the taxonomic significance of the reduction, modification and fusion of the basal abdominal segments in Hemiptera-Heteroptera, and I have also proved (1956) that each particular type of modification in the basal abdominal segments in the genus *Rhagovelia* (Veliidae) occurs on the subgeneric level. The principles that I suggested in 1955 seem to exist in the metathorax as well as in the basal abdominal segments in the Gerridae.

ACKNOWLEDGMENTS

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OBSERVATIONS ON THE ETHOLOGY OF SOME BRAZILIAN COLLETID BEES (Hymenoptera, Apoidea)[1]

CHARLES D. MICHENER[2] AND RUDOLF B. LANGE[3]

INTRODUCTION

The purpose of this paper is to present the results of some rather fragmentary studies on the behavior of colletid bees made in the state of Paraná, in southern Brazil. The majority of the observations recorded herein were based on nests found in a series of roadside banks near Curitiba, Paraná, which are the subjects of more extensive treatment relating to the ecology of their bee inhabitants (Michener, Lange, Bigarella, and Salamuni, 1958). The reader is referred to that paper for some information on the climate, on the soils involved, etc. These banks are called Barigui roadside banks in the present paper in order to identify the locality.

The family Colletidae is of special interest because it contains the presumably most primitive bees with a broad truncate or bifid glossa as in sphecid wasps. According to Herbst (1922), Claude-Joseph (1926), Rayment (1935), Ruiz (1942, 1944), etc., it is with this glossa that bees of this family lay down the cellophanelike cell walls which are characteristic of the nests of this family. According to Ruiz, *Colletes,* like *Chilicola* whose behavior was described by Herbst and Claude-Joseph, uses the glossa like a paint brush to apply a viscous substance which he believed to be produced by glands opening near the base of the tongue.

Presumably the existence of the cellophanelike material used in nest construction by the adult female has made unnecessary among Colletid bees the more or less impervious cocoon produced by the mature larva which is so characteristic not only of sphecid wasps but also of many bees whose adults do not provide water tight cells. In general, as pointed out elsewhere, colletid larvae do not construct cocoons. It is therefore of interest to find a species of *Colletes* whose larva constructs a thin cocoon inside the usual cell wall made by the adult.

The ethology of Paracolletinae is of interest because this subfamily has been considered to contain the most primitive of bees (Michener, 1944). Not only is it apparently primitive structurally but it has a distribution in the southern continents (South America, Australia, and South Africa) like

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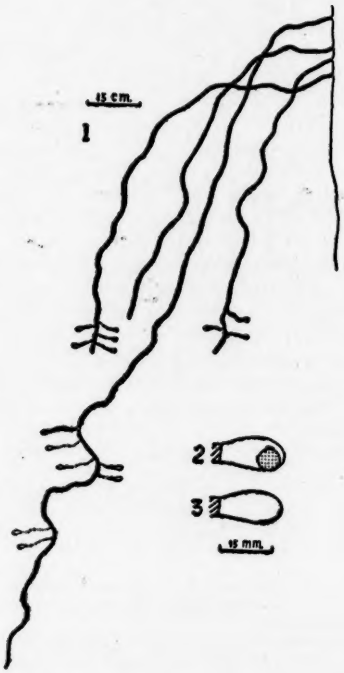
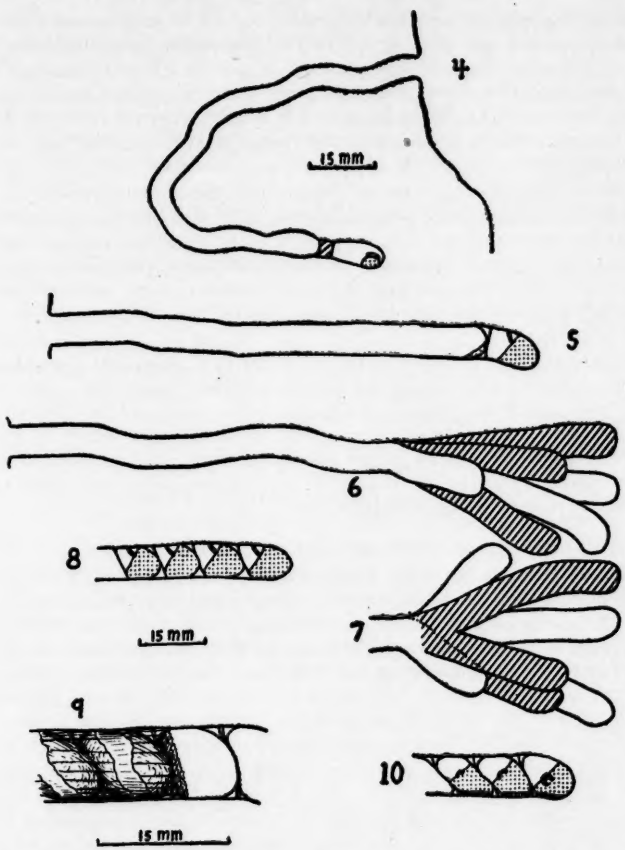
many ancient groups. Behavior of this group, therefore, should be of value in judging the primitive characteristics of bee behavior from which more advanced types have arisen.

Most nests of Paracolletini, to judge by Rayment (1935), consist of a main burrow which is typically more or less vertical and which gives off from near its lower end one or more rather long horizontal or sometimes slanting burrows, each ending in a single cell. Nests of *Edwyniana tristis* (Spinola) (Janvier, 1933) and *Lonchopria cingulata* Moure, described below, are of this general type. The laterals may be completely filled with soil and unrecognizable except for one leading to a cell being provisioned. The burrows are not lined. The cells are smooth enlargements of the ends of the lateral burrows, subhorizontal in position, lined with a thin translucent membrane.



EXPLANATION OF FIGURES

1. Nests of *Lonchopria cingulata* Moure, side views. Lateral burrows filled with earth are shown in dotted lines. 2. Side view of cell of *Lonchopria cingulata* Moure showing ball of provisions (dotted) and egg on top of it. 3. Side view of cell of *Lonchopria cingulata* Moure showing feces deposited by larva. Earth closing cell shown by oblique lines.



4. Nest of *Belopria zonata* Moure showing a side view of a completed cell with ball of provisions (dotted) and egg, closed by earth plug (oblique lines), and second cell ready for provisioning. 5. Side view of nest of *Colletes michenerianus* Moure with one completed cell with provisions (dotted) and egg and another cell being provisioned. Thick lines indicate the extent of the cellophanelike lining of the burrow. 6. Side view of nest of *Colletes michenerianus* Moure. Cells not shown; previous year's burrows shaded. 7. Top view of same nest. 8. Side view of cell series of *Colletes michenerianus* Moure, showing provisions (dotted) and eggs. 9. Side view of part of cell series of *Colletes kerri* Moure, showing only the cellophanelike membranes of which the cells are constructed; at right they are shown in sectional view. 10. Side view of cell series of *Colletes kerri* Moure showing semiliquid provisions (dotted), beneath which is dry pollen (shaded). Young larvae are floating on provisions.

That the features listed above characterize the basic primitive type of subterranean bee nest is suggested by the occurrence of essentially similar nests (except for vertically oriented cells) in various other Colletidae (*Caupolicana, Ptiloglossa,*[4] *Policana, Cadeguala,* observations of Claude-Joseph, 1926; Janvier, 1933). Other groups of relatively primitive bees also have similar nest patterns (*Protoxaea,* observations of C.D.M.; *Andrena,* Michener and Rettenmeyer, 1956).

Not all Paracolletini, however, exhibit this type of nest structure in unmodified condition. For example, *Belopria,* described below, is exceptional in having two or more cells, end to end, in a single burrow, and *Lonchopria zonalis* (Reed) apparently sometimes has cells in rows (Both Claude-Joseph, 1926, and Ruiz, 1944, give some information on this insect under the name *Lonchopria marginata* Spinola. Father Moure has indicated to us the probable correct name.)

In the Colletini, a few species of *Colletes* (e.g. *inaequalis* Cresson, see Stephen, 1954) build nests on the pattern of typical Paracolletini, and a few (e.g. *musculus* Friese, see Claude-Joseph, 1926) build isolated cells at the ends of short laterals. Most, however, like those described below, construct nests in which the cells are highly variable in shape and are constructed in series merely by means of transparent membranous partitions across a tube of similar material lining a burrow.

Lonchopria cingulata Moure

As explained by Michener, Lange, Bigarella and Salamuni (1958), some 2800 nests of this species were found concentrated in a single area of the Barigui roadside banks, Curitiba. The bank concerned was vertical or nearly so, and 4 to 5 meters high, facing north. It contained numerous old holes of this species, indicating use of the bank for years. Most of the nests entered the bank directly but concentrations occurred in any pit in the bank; thus when we excavated nests during the construction season, numerous nest burrows were promptly started in the walls of the excavation.

The species was first observed on September 16, 1955, when two females were seen flying about the bank. On September 18, two more were seen, and on September 20, many. Males were seen on *Baccharis* flowers from September 25 to October 1 but females were never seen on these flowers; we never did learn the source of their pollen. On September 29 nest digging was in full swing, with bees pushing large quantities of soil from nests. Several burrows were excavated for study; they ranged from 20 to 34 cm. in depth and were still being constructed, there being no cells as yet. There was no evidence that old burrows were ever re-used. On October 1 much digging was still going on but some bees were already carrying large loads

[4] Descriptions of *Ptiloglossa* nests by Schrottky (1906, 1907) are not very full and suggest a somewhat different pattern but nests opened by C.D.M. in Mexico were similar to those of *Caupolicana.* Furthermore, it is appropriate to mention that not all species of *Caupolicana* have nests of the form described for Paracolletini, for Janvier (1955) describes species making horizontal burrows in banks with vertical cells descending at intervals along the burrows.

of white pollen into the burrows. By October 27 only a few females were still active, carrying pollen.

The nests are smooth walled but unlined burrows 7 to 8 mm. in diameter, each constructed by a single female bee. They usually enter the bank more or less horizontally, then descend more steeply (figure 1), but may slant down from the entrance. The burrows are slightly winding, not straight. They are always open, not being closed by the bee even at the end of her nesting activities.

The cells are at the ends of subhorizontal branch burrows 5 to 10 cm. long along the lower part of the main burrow. The branches are of about the same diameter as the main burrow, narrowing to 5 mm. at the cell mouth, and are not lined with any visible wax or cellophanelike material. Only one branch is open at a time, probably each branch being filled by earth taken from a new branch. The earth is so well packed into the branch burrows that they often cannot be distinguished from undisturbed soil. For this reason, the connection of cells to their burrows are impossible to trace and the number of cells per nest could not be determined, especially because of the many nests and associated old burrows. We have the impression that five, eight, or possibly ten cells are constructed per nest. Needless to say, nests ranging up to two meters deep are not ideal for study; we excavated only a few and attempted to map out the cells in detail for only three.

Cells are horizontal, 17-18 mm. long (fig. 2), about 9 mm. in diameter, the upper surface more evenly concave than the lower, and are lined with cellophanelike material which does not easily pull from the cell wall as it does in *Colletes* and *Belopria*. The pollen is placed in a spherical ball 6 mm. in diameter held together by enough nectar or other liquid to be firm. The unusually small egg, 2 mm. long and scarcely curved, is laid on top of the pollen ball.

On October 27, 1955, several cells contained eggs, others very small larvae, and one was opened which had a larva about one-third grown. One living and apparently healthy prepupa was also found in a cell at this time, indicating that a few individuals may not emerge at the normal time but perhaps remain in the soil for an extra year. By December 9 all young were prepupae. Fecal material is deposited as a layer in the lower distal portion of the cell (fig. 3). *Lonchopria* remained in the prepupal condition throughout the summer and fall, but on June 1, 1956, of ten cells opened that contained live bees, nine were prepupae, one a new white pupa. On June 28, of ten cells opened, five contained prepupae, three contained male pupae, and two, female pupae.

As a summary of the seasonal activity, it can be said that this bee appears in the adult stage only in the spring, that there is but one generation per year, that the larvae finish their growth rather rapidly, perhaps in less than a month, so that in early summer all are prepupae, in which stage they remain until early winter when pupation of at least some individuals occurs. Others probably do not pupate until midwinter or later.

Belopria zonata Moure

As shown by Michener, Lange, Bigarella, and Salamuni (1958), nests of this species were not found in a large aggregation like those of *Lonchopria,* but were in several small, dense aggregations in banks facing in a generally northerly direction. They were consistently near the upper level of the decomposed gneiss forming most of the Barigui roadside banks, i.e., in the layer termed C 1 in the paper referred to. This is somewhat unusual for the majority of bees seemed to prefer layer C 2.

This species was first observed on September 14, 1955, when two females and a male were excavated from isolated simple burrows, 4 to 13 cm. deep, in earth banks near São José dos Pinhais, Paraná. All other observations were made at the Barigui roadside banks. Both sexes were common on flowers of *Baccharis* in this vicinity from September 15 to 30, but were not seen after the latter date. A dozen nests were found with fresh earth at the entrances on September 18. These nests were in the vicinity of old burrows, none of which was occupied; evidently this bee does not re-use old burrows.

The new burrows were opened for study. As always with this species, they were irregularly winding so that the cells are often quite near the bank surface. In diameter they vary from 5 to 6 mm; they are not lined and are not plugged with soil by the bee even when she abandons the nest. One was still being excavated, but the others, which varied from 7 to 15 cm. in length, all ended in a single cell, sometimes rough, in other cases already provisioned, provided with an egg and closed.

The first cell is constructed at the end of the burrow, then one or two others often are constructed by enlarging the same burrow (fig. 4), so that a short series of cells in the same burrow results. If branch burrows like those of *Lonchopria* are made, they are so obscured by being filled with soil as to be invisible. If no branch burrows are made, each female probably makes two or more nests, for every few cells (often but one) were found in each nest. The close proximity of nests, and intermixed old nests, so that sites are quite honeycombed, make a more detailed study necessary to clarify these matters.

Cells are subhorizontal, about 12 mm. long by 5 mm. broad, narrowed to about 3 mm. at entrance. The cells are lined with a cellophanelike material which is not so transparent as in *Colletes.* The upper surfaces of the cells are more evenly concave than the lower (fig. 4). The pollen is placed in a firm ball, distinctly flattened in the vertical axis, near the distal end of the cell. Dimensions of the pollen ball are 3 to 3.75 mm. in horizontal diameter, 2.2 in vertical diameter. The egg, laid on top of the pollen ball, is almost 2.5 mm. long, distinctly curved, smaller near the posterior end than at the anterior end. It is thus distinctly larger than that of *Lonchopria,* although the latter bee is nearly twice the size of *Belopria.* The cell plug has a spiral pattern on the inner surface and is 2.5 or 3 mm. in thickness.

On October 9 a three-fourths grown larva was found; on October 17 two cells containing larvae about one-third grown were opened. On November 15, December 21, January 29, 1956, February 9, and March 24 nests were opened; some had been destroyed by ants but a total of about a dozen bees

were found, all in the prepupal stage. On June 1, among six occupied cells, three contained prepupae and three young white pupae.

A summary of the seasonal activities of *Belopria* would be the same as that for *Lonchopria* given above. Aside from size of the bee, the nest, and especially of the egg, the principal difference between nests of these bees is in arrangement of the cells.

Bicolletes iheringi (Schrottky)

Nests of eight individuals of this species were found on December 21, 1955, all in a single location in a Barigui roadside bank (soil C2 of Michener, Lange, Bigarella and Salamuni, 1958). The average distance between nest entrances was less than 1 cm. This tiny dense aggregation was in a bank facing north but shaded by a strong overhang.

The burrows were not over 8 cm. long; after entering the bank for a few centimeters they curved back so that the cell at the end of each burrow was quite near the surface of the bank. The burrow walls were not lined.

The end of each burrow was enlarged to form a cell, only two of which were completed. One already contained a firm ball of pollen, the other was emptly. Completed cells were lined with cellophanelike material.

Lüderwaldt (1910) describes clustering habits of this bee in bushes.

Perditomorpha brunerii Ashmead

A female was found digging a vertical hole at the base of a bank on February 21, 1956, at São José dos Pinhais, Paraná.

Another female was found in a vertical hole in a small horizontal step in a Barigui roadside bank on March 4, 1956. This burrow was about 15 cm. deep with a horizontal lateral burrow leading off about 4 cm. from the bottom. No cells were in evidence but the presence of a horizontal branch suggests a nest of the same basic type as *Lonchopria*.

Colletes michenerianus Moure

This species was first found nesting by one of us (C.D.M.) in company with Father J. S. Moure in an earth bank facing west near Guarapuava, Paraná, on September 8, 1955. A female was removed from a new burrow (not associated with an old one); she had lined the extremity of the burrow with cellophanelike material but had not started provisioning. A male was found in the same bank, in an old burrow containing a single series of three cells, all of them partially earth filled. Both burrows showed fresh earth recently pushed from the entrances. Both sexes were found at flowers on this same day.

Our other observations of this species were made at the Barigui roadside banks, where a few scattered nests were found on a bank facing southwest, as indicated by Michener, Lange, Bigarella and Salamuni (1958). They were in soil of layer C2, as described in the above mentioned paper.

The nests were 8 to 14.5 cm. deep, burrows 7 mm. in diameter, the walls of the burrows not smooth, but showing the marks made by the mandibles of the bee in digging. On September 18 one nest (not associated with one of previous year) consisted of a simple burrow, the inner 22 mm. of which was

lined with transparent cellophanelike material; as yet there were no provisions. Another nest, also a simple burrow not associated with a nest of the previous year, was lined for 27 mm. and contained one completed cell with an egg and a second cell was being provisioned (fig. 5).

On October 9 another nest was excavated. It was apparently already abandoned by the mother, a conclusion supported by our failure to see bees of this species on flowers after about October 1. It had taken advantage of a previous year's nest of the same species, and consisted of an unlined horizontal burrow entering the bank for 8.8 cm. at which point three old, earth-filled subhorizontal burrows and four new similar burrows radiated (figs. 6 and 7). The branch burrows were lined with cellophane-like material and nearly full of cells. The number of cells per branch burrow is shown in the following tabulation:

Old branches	No. of cells	Total cells
1	2	
2	2	
3	1	5
New branches		
4	4	
5	3	
6	3	
7	1	11

The entrance burrow was not closed by the bee in this or any other abandoned nest studied.

The cells are constructed of cellophanelike material in series, occupying the burrow or its branches. They are 6.5 to 7.5 mm. in diameter. Their length varies considerably, the distal one being longer (12-13 mm.) than the others (9-10 mm.), doubtless because the rounded apex of a burrow holds less provisions per unit of length than other sections. From the data presented above it is obvious that the bee first lines a considerable length of burrow with cellophanelike membrane. She then packs pollen into the end of the burrow to form a rather firm pollen mass, firm enough that the front stands in an almost vertical position, then lays a white egg about 2.75 mm. long on the pollen mass in the position shown in figures 5 and 8, then closes the cell with a transverse membrane. She then constructs a second transverse membrane, concave toward the nest entrance, and starts provisioning another cell. Thus there are two transverse membranes between cells, the space between them being empty. The provisions apparently become a little more liquid with time so that they slump down against the membrane that closes the cell (fig. 8). Branch burrows are constructed, seemingly starting at the proximal end of the lined portion of the original burrow. On October 9, only eggs were found in the cells but a nest opened on November 18 contained only a single completed cell, and in it, a mature larva, while a nest opened on December 11 contained prepupae. Each was enclosed in a very thin, light brown cocoon made up of fibers, with the spaces between the fibers filled with pale brown amorphous material. The

cocoon was constructed against and adhered to the cellophanelike material of the nest except where feces were between the cocoon and the nest material. This is the only *Colletes* that we know that constructs a cocoon.

Judging by few flower collection data, plus the nesting data presented above, it appears that this handsome metallic blue *Colletes* has one generation per year. The adults fly in early spring. Larvae reach maturity in late spring and pass the summer as prepupae.

Colletes kerri Moure

We first encountered nests of this species on January 13, 1956 in a bank almost within the town of Araucaria, Paraná, where Dr. W. E. Kerr of Piracicaba, São Paulo, was particularly helpful in finding and excavating them. The burrows were approximately horizontal, 6 to 10 cm. deep, and 8 to 9 mm. in diameter. They were scattered, not in any definite aggregations. Many of the nests divided 3 or 4 cm. from the entrance to form two or sometimes three branches containing series of cells, similar to those of *C. michenerianus*. In many cases the entrance burrow, which is unlined, was being used for the second year, some old, earth-filled branch burrows with the remains of the cellophanelike cell walls being present, most commonly just above the branches currently in use. At this time the cells contained pupae, already dark in color, and one adult female was found which had started a new burrow 3 cm. deep. Nineteen pupae brought into the laboratory and kept at 20°C emerged as adults between January 20 and February 4.

At the Barigui roadside banks *C. kerri* was first seen on February 8, when two females were observed flying about the banks. A few scattered nests were subsequently located there, as noted by Michener, Lange, Bigarella and Salamuni (1958), most of them unbranched and with few cells. Bees were seen provisioning nests as late as February 26. Five cells excavated on March 4 all contained small to middle sized larvae.

The cells themselves are constructed much as in *C. michenerianus*. The branch burrow is largely lined with cellophanelike material; then, as cells are provisioned, it is divided by transverse cellophanelike partitions. Often the branch burrows are somewhat compressed so that the vertical diameter is greater than the horizontal; these diameters vary between 8 and 9 mm. The walls between the cells slant strongly so that measurements of cell lengths mean little (fig. 10); measurements along one side vary from 6 to 11 mm. The transverse membrane which closes a cell is convex toward the nest entrance (although it may not be at the time of construction); each new cell in the series is based upon a second membrane which is concave toward the nest entrance and is in contact with the first medially. The presence of these two cellophanelike transverse membranes between each cell is much as in *C. micherianus*. However, *C. kerri* usually has two very thin and sometimes incomplete additional membranes between the principal ones, so that the partition between two cells usually consists of four membranes (fig. 9). The cellophanelike material actually consists of fine white fibers imbedded in a transparent matrix. In the additional membranes

mentioned above, these fibers are sometimes free and form cottony masses in some places.

The provisions in the cells consist of a small amount of *dry* yellow pollen in the bottom of each cell (fig. 10); the rest is a dark brown semiliquid mixture of pollen and honey. The egg stage was not seen, but young larvae, recently hatched, float curled on top of the semiliquid food. Larger larvae float with the dorsal parts of the middle segments exposed, the ends of the body curled down into the food medium. Mature larvae pack the feces into a black layer 0.2 to 1 mm. thick, completely surrounding the mature larva and later the pupa. The feces are separate pellets, soft enough to cling together. No cocoon of any sort holds the feces in place.

This species is parasitized by *Isepeolus viperinus* Holmberg. Of 27 cells from Araucaria, 2 were moldy, 6 contained *Isepeolus,* and 19 contained *Colletes,* while of 5 cells excavated at Barigui on March 4, 2 contained *Isepeolus larvae*. The details of what we know of *Isepeolus* will be published elsewhere (Michener, 1957).

Apparently this bee has but one generation per year, adults appearing in midsummer.

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